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DISCOVERY

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BUILDING A MODERN TELESCOPE ● SEPARATING ISOTOPES

● ANIMAL POISONERS ● BLOOD TRANSFUSIONS

INVITATIONS TO KNOWLEDGE. VII: Fundamentals of Photography

DISCOVERY

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The Fate of Homo Sapiens*

THERE was a certain grim appropriateness in reading this book in the last days of August 1939—and reading it, as it happened, in a garden where the grass was being lifted to make a trench and so disturbed for the first time for several hundred years. It was hard to read Wells's book in that garden without being overmastered by a single emotion—nothing as tranquil as a sense of tragedy nor as simple as fear, but instead just sheer frantic *irritation* at the whole petty, silly history of man.

I do not pretend that it was a very lofty or suitable emotion. But it was real while it lasted. If Wells's book evokes it in many people, then the darkest side of his prophecy may conceivably not come to pass. If, that is, enough people are irritated beyond endurance and begin to say "This is an intolerable world. Unless we take steps at once, everything that we value in mankind now, and hope for in the future, will have disappeared for ever. We have got to fight and think. We need courage. But courage is not enough. We have got to adapt ourselves to sudden change. Unless we do, man will become nothing but a cunning predatory little beast, equipped with his wireless sets and his aeroplanes and his guns, busying himself with a fatuous ingenuity over his silly little squabbles until he comes to a deserved end. If the race is to be saved, we must fight and *think*. It will not be saved by your orthodoxies, by the narrow peasant selfishness of the right or the childish make believe of the left. If it is to be saved at all, it will be saved by those

* *The Fate of Homo Sapiens.* H. G. Wells. (Secker and Warburg, 7*s.* 6*d.*)

who know that the race is one: who know that it is doomed unless it acts as one: who will fight for it to be made one (as Lincoln fought for the United States). *This present war is a civil war of the world.* We must win it: and while winning it, and after winning it, begin building the world state."

To make people think in such a fashion is Wells's purpose in this book. His argument is plain; either the race must unite now, and show the collective intelligence and devotion which sections of it often show for limited purposes (think, for example, of the unselfishness, the responsibilty, and the good mental energy spent over the task of evacuating children from London: and then think again of what that energy might have done if applied to the state of Europe in 1919), or else it will degenerate, its living will slip from lower grade to lower grade, and within a relatively short time the race will perish.

The analysis has the power, information and lucidity of all Wells's work: only the frivolous will try to dispute it. There are a few points of detail on which I should like to raise some qualifications; the chapter on Judaism is tinted with dislike; he undervalues Marx's method in its *interpretation* of history, though he is right in condemning it as an automatic recipe for action; he does not admit how similar in effect Freud's and Marx's discoveries have been, how both have unearthed, in their different fields, the irrational, unconscious and unrecognised motives in human affairs, and how those revelations have produced the most critical intellectual difficulties of our time. Possibly also he underestimates the toughness of technological civilisation. It seems likely that an animal as ingenious as man will keep his tricks even if he loses his values; and that he is more likely to survive, in a debased Babbitt form, than Wells allows.

But those are all very minor points of difference. His main case remains: either we exert ourselves now, or everything worth calling human will be lost, just as the great reptiles were lost. Which is it to be? None of us knows: we can only do to our own limit. One thing is certain. None of the orthodoxies will save us now. That thought is moving a great many independent-minded men: if you read J. B. Priestley's "Rain upon Godshill", a book full of originality and wisdom, or Peter Drucher's "The End of Economic Man", the most profound book on political things written for years, you will find two vigorous minds going the same way.

The impact of Wells's book is so great that one almost forgets to say how much one admires it. He is, of course, one of the most remarkable of English writers; and so vitally gifted that his juniors' attempts to disparage him have a peculiarly seedy look. It strikes one again how astonishingly *inventive* he is: he has only to look at a bit of the world to see it in a fresh light, to put a fresh construction on it. In just the same way he invented a telpherage system for the trenches, adumbrated the idea of the tank and gave a new tang to every paragraph he wrote. For sheer invention no writer has ever touched him; and you have to go to Leonardo or Clerk Maxwell before you can find a just comparison.

And one other thing. This book is deeply pessimistic. That ought to move us more than the pessimism of many writers; for Wells's is not the dark sense of life which some feel by instinct, but the reluctant result of experience. His sad wisdom he has learned step by step, about the fate of the race as about individual human beings: for in "Apropos of Dolores" we find a picture of a woman that reveals him expecting incomparably less than in the novels of the earlier years. He is one of the few men who have gone on learning until he is old; and from his present wisdom we can draw, not exactly comfort, but a kind of stoical strength. C. P. S.

Building a Modern Telescope

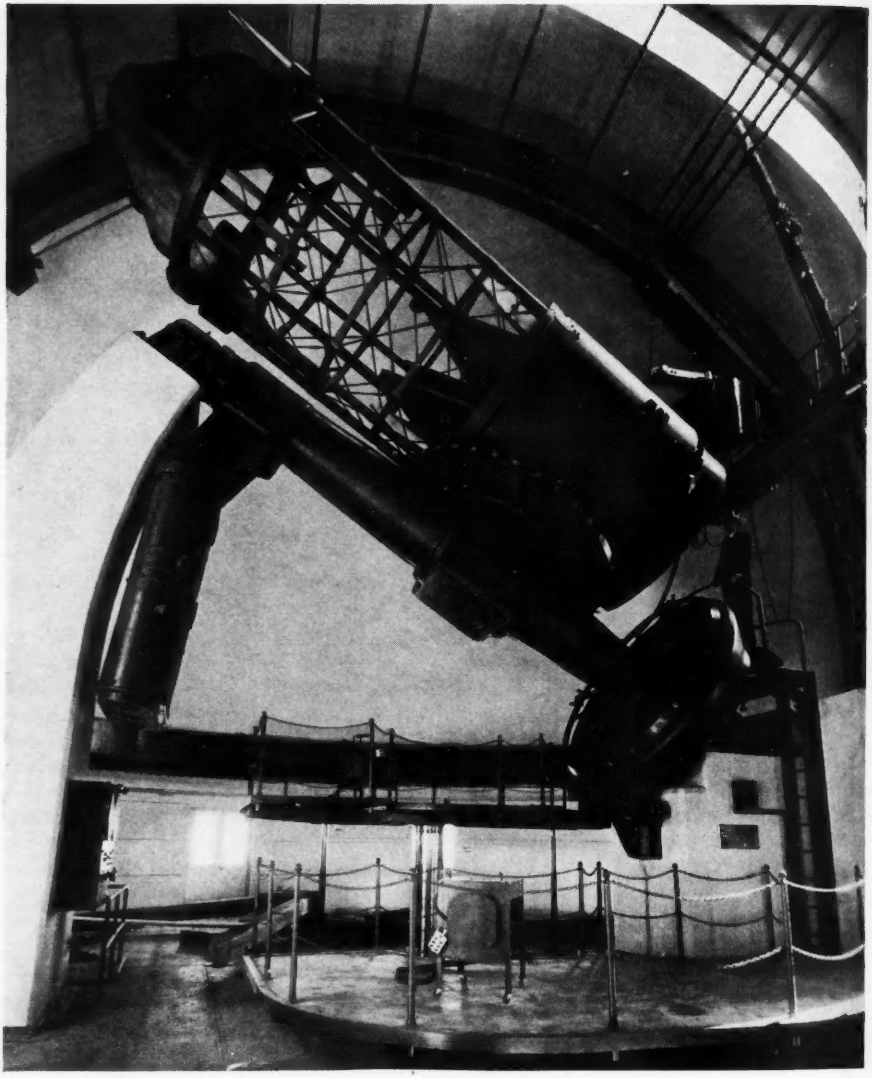
By David S. Evans

(*"Already, after only two months' work, what may be an entirely new type of star has been discovered...." Mr Evans, of the University Observatory, Oxford, here writes of the great progress in astronomy made in consequence of the erection of two new telescopes.*)

The first telescopes ever constructed were refractors made from spectacle lenses of very small aperture, on a principle very similar to that of the modern opera glass, and this remained the only form of telescope until, in an effort to overcome the defect of chromatic aberration, Gregory and Newton invented the reflecting instrument. The first successful reflecting telescope was constructed by Newton in 1672. With the invention of the achromatic lens the refractor seemed likely to regain its former predominance, but as the science of astronomy progressed, and ever larger telescopes were required, experience soon demonstrated that for large telescopes the reflector was very much superior to the refractor.

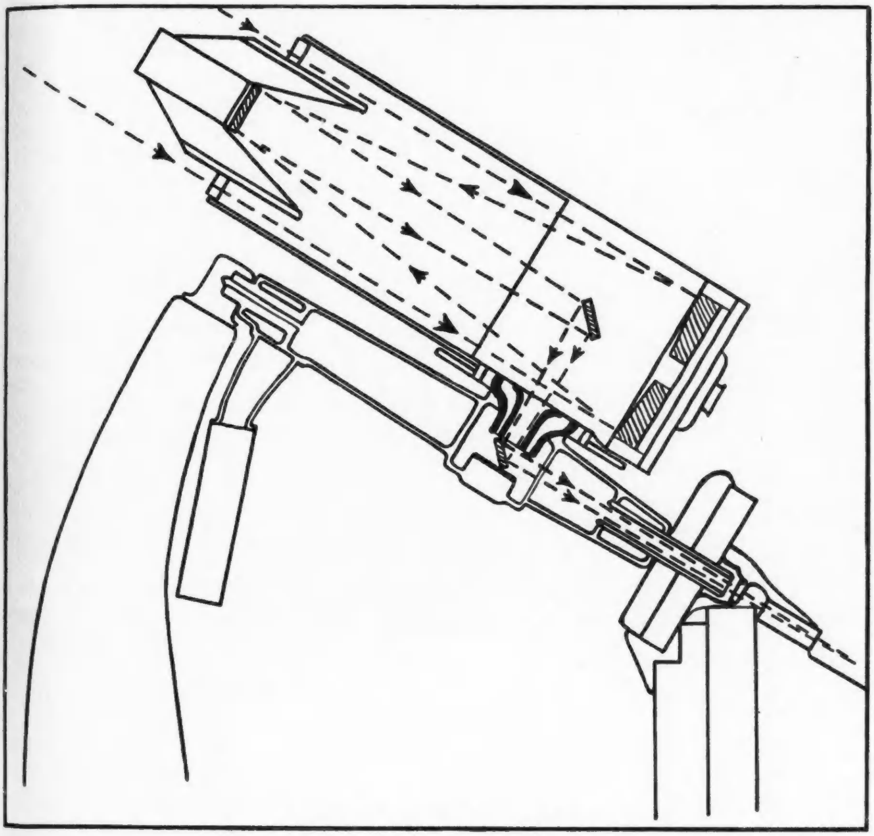
Since a lens must leave its whole aperture free it can only be supported at its edges, and thus in addition to the difficulty of obtaining a large disk of glass free from defects throughout its mass, there is the even more serious problem of mounting such a disk by its rim alone so that it will not become distorted under its own weight. A mirror enjoys the advantage that it can be supported all over its back surface, and the disk need not be completely free from blemish throughout because all that is required of it is that the front face which carries the silver or aluminium reflecting coat shall preserve its shape accurately. Hence, for large telescopes in which the glass may weigh several tons, the difficulties of constructing a concave mirror which will retain its figure to within the one four-hundred thousandth part of an inch are, although enormous, very much less formidable than those which beset the manufacture of a lens of the same size and accuracy.

When the form of the telescope is decided, the next problem is the choice of a suitable site. At the equator all the stars are above the horizon half the time, while at the poles half the stars are above the horizon all the time. The choice of a compromise between these two extreme conditions is influenced by general climatic conditions, such as the



The McDonald Telescope. Note the fins carrying the camera and the counterweight close to the pier

avoidance of extremes of temperature. Perhaps the best latitude for an observatory is about 30° north or south of the equator, and the southern latitude is likely to be preferred (other things being equal), because in the past the northern sky has been studied much more closely than the southern.

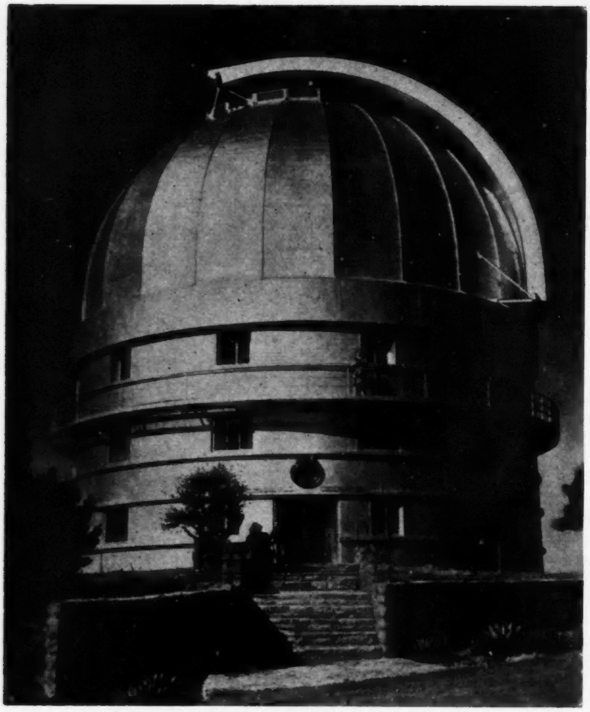


Simplified drawing of the mounting of the McDonald telescope in the coudé form. The paths of the light rays are indicated by dotted lines, and the mirrors are shown shaded

Further, the local peculiarities of the site must be studied with great care, in order to avoid regions where dust storms or city smoke would spoil the visibility. In all the years of its journey through interstellar space starlight suffers less absorption than in the minute fraction of a second which it spends in crossing the earth's atmosphere, so that it is a decided advantage for a telescope to be at such an altitude that the bulk of the atmosphere lies below it.

These are some of the conditions which the ideal observatory site must satisfy, and there are in fact very few areas of the earth's surface where they can all be met, and which at the same time are in regions where political conditions are stable and where the necessary technical and engineering services are available.

Two new observing stations have recently been established on sites which are almost ideal. One is on Mount Locke in Texas where the Warner and Swasey Company of Cleveland, Ohio, have recently completed an 82in. reflector for the McDonald Observatory, and the other is near Pretoria,



The Dome of the McDonald Observatory

Union of South Africa, where the 74 in. reflector of the Radcliffe Observatory is nearing completion. Mount Locke is about 6800 ft. in height and is situated in the dry ranch country of western Texas in latitude 30° N. and about 17 miles from the town of Alpine. The Radcliffe telescope is on a site presented by the Municipality of Pretoria about 5000 ft. above sea-level and in latitude 26° S.

The establishment of the McDonald Observatory is the result of a bequest by the late W. J. McDonald of Paris, Texas, who left about $1,000,000 to the University of Texas for the establishment of an observatory in connexion with that University. The will was contested by his surviving relatives, and an arrangement was finally made by which the University was left with about $800,000 at its disposal, a sum which was considered to be inadequate both for the erection and maintenance of a large telescope. The problem was finally solved by the co-operation of the University of Chicago, and a scheme was evolved whereby the greater part of the capital sum was to be devoted to the construction of a large reflecting telescope, and the cost of administration and the provision of personnel was to be shared between the two institutions. The direction is in the hands of Dr Otto Struve of the Yerkes Observatory of the University of Chicago. On 5 May of this year the McDonald telescope was formally dedicated. The occasion was a brilliant one and was marked by the presence of distinguished astronomers from all over the United States. A conference lasting several days was held at which a number of the most prominent astronomers of Europe and America described recent advances of theory and observation.

The Radcliffe Observatory is a much older foundation which has recently been transferred from Oxford, where it was originally established in 1772 under the will of Dr Radcliffe, with Thomas Hornsby as the first Radcliffe Observer. Its work in its new home will be carried out with a large reflecting telescope similar in a number of respects to the Texas telescope, and the two instruments may conveniently be described together. This description must, however, be prefixed by a short account of the simplest principles of telescope design.

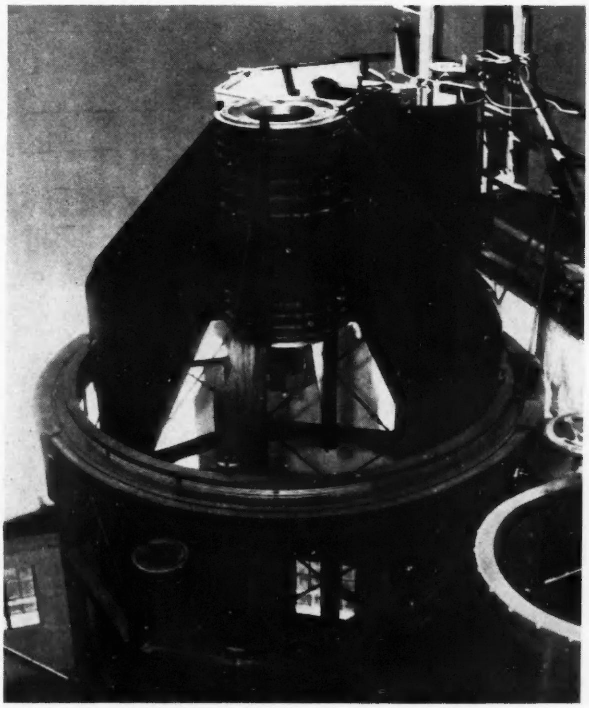
Every telescope has to be mounted so that not only can it be pointed to any part of the sky, but can be made to follow any selected object in its apparent motion across

the sky. This motion is the reflexion of the earth's rotation about its axis, and hence the second requirement is met by mounting the instrument on an axis (called the polar axis) which is parallel to that of the earth, turned through one revolution in each sidereal day. The first requirement is met by providing a second axis, called the declination axis, at right angles to the polar axis on which the instrument may be swung up and down or clamped in any position.

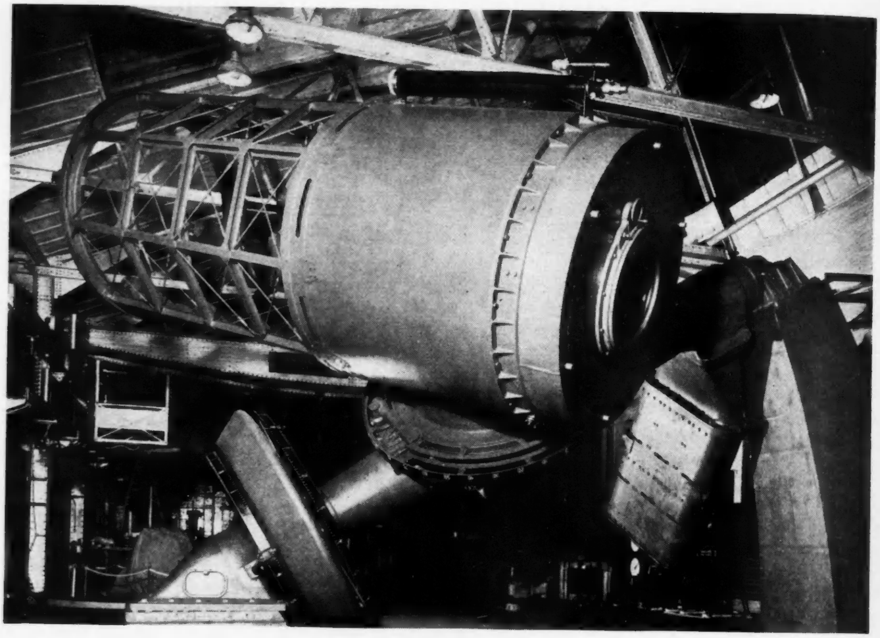
In both the McDonald and the Radcliffe telescopes the polar axis is an enormous mass of steel mounted at each end in huge bearings supported on concrete piers, and the telescope tube itself is hung on its declination axis to one side of this shaft. The moving parts of the McDonald telescope weigh 45 tons and the tube alone more than 13 tons, so that the problem of mounting weights of this size in a way which will allow the telescope to be moved about without difficulty and without becoming distorted under its own weight is one whose solution demands tremendous engineering skill. In addition the mounting must be designed in such a way that all the optical possibilities of the great mirror may be fully exploited.

Most large reflecting telescopes are designed so that they can be used in a number of forms, each best suited to a particular type of observation. In the simplest form the incident light travels down the tube to the main mirror, is reflected there and returns to a focus on the axis of the tube where it is received by a camera. In the photographs of the Texas telescope the four large flat fins placed edge on to the beam which carry the camera can be seen at the top end of the openwork tube. This arrangement has the disadvantage that only small pieces of apparatus can be placed in the tube because large ones would interrupt the light beam. In the Newtonian form a small tilted mirror is put in the tube to reflect the beam at right angles. In this form the camera is mounted on the outside of the tube. This arrangement is not suitable for spectroscopic work, however, because the modern high-dispersion spectroscope is a very heavy instrument and would be very liable to distort the telescope if it were mounted at the extreme end of the tube. The ideal arrangement is one in which the telescope acts merely as a collector of light and follows the star under observation round the sky, while the spectroscope remains fixed in a room whose temperature can be controlled.

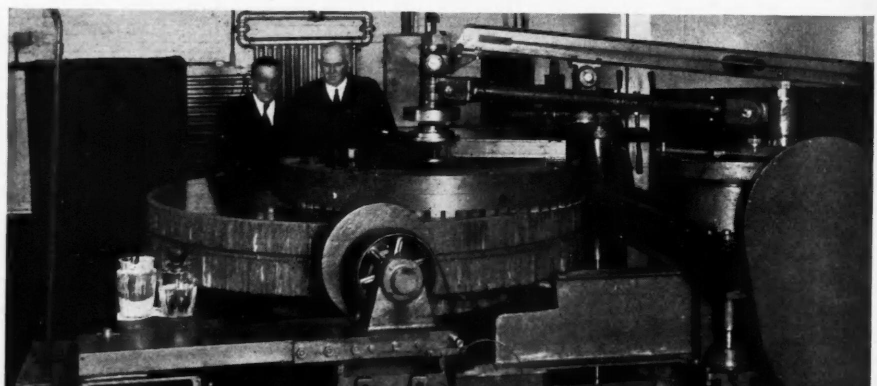
The designers of these two telescopes



The tip of the McDonald Telescope



The McDonald Telescope



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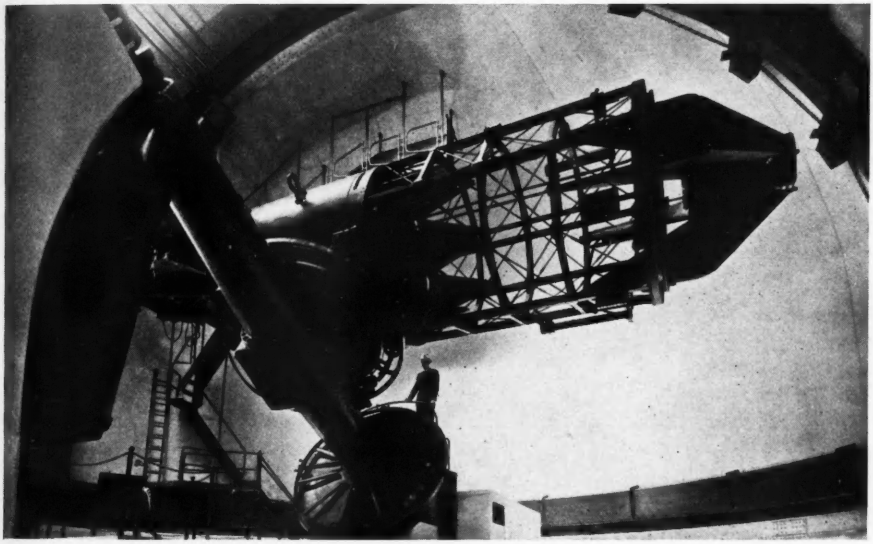
have achieved this object in rather different ways. In both, the axes of the mounting have been made hollow, and the light is taken out of the main tube by means of a small mirror tilted at 45°, and is fed down the inside of the declination axis to the point where this meets the polar axis. Here it is turned by another mirror and passes right down the inside of the polar axis, through the end pier and into the spectrograph room. The path followed by the light is shown in the diagram. This arrangement, known as the coudé form, solves the optical problem, but it complicates the engineering problem enormously. Not only has the telescope tube to be hung off at one side of the polar axis with a counterweight on the other side to balance it, but both polar axis and declination axis have to be made hollow and yet rigid enough to remain undeflected in all positions.

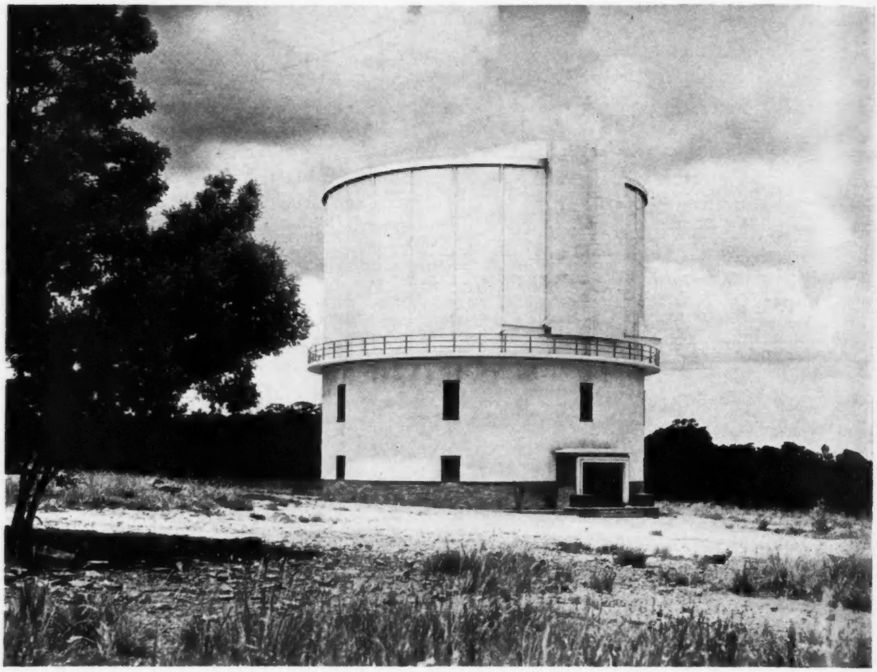
The photographs show how the engineering problem has been solved in the two cases. The Warner and Swasey Company contrived it by moving the counterweight close up to the north pier where it did not interfere with the beam from the telescope and left the floor space free for the observing lift, while Sir Howard Grubb, Parsons and Co., left the counterweight in its usual position opposite the declination axis, but expanded the middle of the polar axis into an enormous cube to leave room for the beam, and attached telescope and counterweight to opposite faces.

The McDonald telescope is housed beneath a dome 60 ft. in height and weighing 115 tons, which is mounted on rollers and is turned by an electric motor. Beneath the observing deck are dark rooms, workshops, living quarters for bachelor observers, a library and a lecture room, while around the main building on the mountain top are scattered a number of cottages for the astronomical staff. All the electricity required has to be generated on the spot, and water supplies are derived from wells specially drilled hundreds of feet into the rock.



Another view of the McDonald telescope

The Radcliffe telescope is housed, not in a dome but in a huge double-walled steel



The turret of the Radcliffe telescope

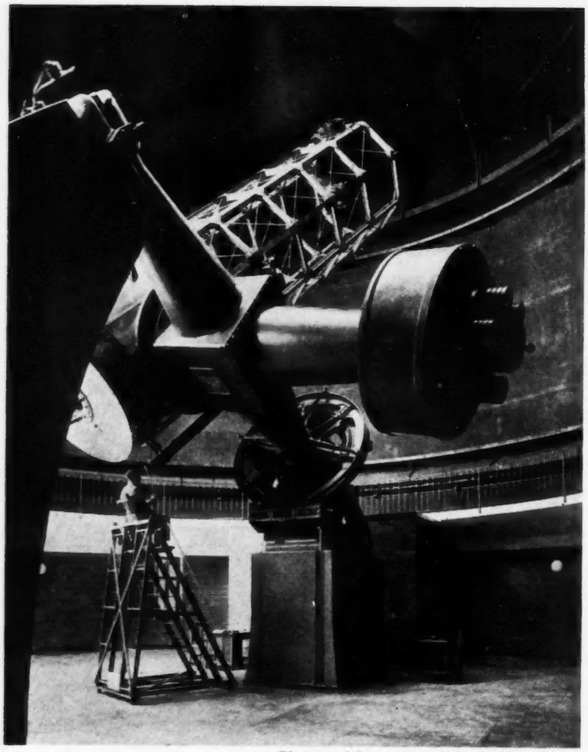
turret which was chosen so that an observing carriage in the form of a long swinging and lifting platform, from which the observer can reach the upper end of the telescope, could be mounted on rails close to the inside wall. The telescope itself looks rather similar to its American contemporary; a similarity enhanced by the fact that the Pretoria Observatory is roughly as far south of the equator as the McDonald Observatory is north of it, and hence the polar axes are about equally tilted, but in opposite directions. Apart from the optical arrangement which has already been described, one of the most striking features of the Radcliffe telescope is the means employed to drive it with the necessary uniformity. This drive is of a type originally used in the McMath-Hulbert Observatory, and is in many ways similar to that installed at the McDonald Observatory.

The telescope is driven through a series of gears from the ordinary direct-current mains by means of a motor, which also drives an alternating-current dynamo. An electrically driven tuning fork, whose vibrations are maintained by a valve unit, feeds a bank of valves whose output circuit is so arranged that as long as the oscillations of the current from the dynamo are in step with the valve output nothing happens, but the instant the valves and the dynamo get out of step the speed of the motor is regulated by the valve output and brought back to its correct value. Thus the hard work of driving the telescope is done by the motor, while the delicate work of regulation is done by the tuning fork. It is hoped that this drive will be accurate to within one second per day.

At the moment of writing the pyrex disk for the main mirror is being figured. It will

Photograph by the courtesy of Dr H. Knox-Shaw, Radcliffe Observatory

The Pretoria Observatory carriage of the Radcliffe telescope



Photograph by courtesy of Dr H. Knox-Shaw, Radcliffe Observatory

The Radcliffe telescope from the south-east

then travel to South Africa via California where there is an aluminizing plant large enough to give it its reflecting coat.

When the telescope is complete it will be used for a study of the intrinsically very luminous O- and B-type stars which can be observed at very great distances, and which provide one of the best ways of discovering the character of the motion of the Milky Way. Such a study has already been made for the northern hemisphere, but the data for the stars of the southern sky are essential for completeness.

In Texas, the McDonald Observatory has already begun work in another important field of astronomical research. This is a comprehensive study of the strange white dwarf stars which are extremely faint and of enormous density, and an understanding of whose structure seems likely to throw light on very many problems connected with the way in which the stars are built, how they manage to go on pouring out radiation into space, why they sometimes explode, and what happens to them in their old age. Already, after only two months' work, several new white dwarfs have been discovered, as well as what may be an entirely new type of star.

The design and construction of each of these telescopes was an engineering feat of the highest order, a combination of microscopic accuracy with enormous strength, which demanded an immense expenditure of skill, brains, and money. They represent an investment which will for many years pay enormous dividends in exact knowledge; knowledge which will be of value, not only in the field of astronomy, but also in the general study of the properties of matter. Only through an understanding of the way matter behaves in its normal smashed-up condition in the stars can we obtain a balanced view of its behaviour under the rare and abnormal conditions which prevail on the earth.

Blood Transfusion

By JOHN YUDKIN

FROM the very earliest times blood has been considered as the source of many of the vital activities of the body, if not actually of life itself. It is not surprising then that for centuries blood was recommended to be taken for a host of diseases and was particularly advocated for the restoration of youth and strength to the aged and infirm. In ancient Rome it was the custom of the spectators to leap into the arena to drink the blood of dying gladiators. The drinking of blood persisted throughout the centuries until quite recently; less than one hundred years ago a potion of fresh calves' blood was commonly prescribed by physicians.

The direct transference of fresh blood into the veins of a man—blood transfusion—is of course a procedure of quite a different order from the drinking of blood. But the early history of transfusion is obscured by the confusion in the records between these two quite dissimilar processes. For example, it was long believed that the earliest case of blood transfusion was that in which Pope Innocent VIII was given the blood of three youths, but it now appears that this blood was taken as a draught by mouth.

In 1615, a detailed description of a technique for blood transfusion was published by Andreas Libavius of Halle. It is unlikely, however, that Libavius did more than suggest the technique, particularly since Harvey's discovery of the circulation of the blood was not published until 1628. The first authentic and successful attempt at transfusion of blood was made in 1665 by Richard Lower, an English doctor. In his experiments, Lower was able to keep alive dogs which had been severely bled, by passing into their jugular veins blood from the carotid arteries of other dogs. It is interesting to note that until very recently, 250 years later, the method of blood transfusion used in man was essentially the same as that used by Lower in his dogs.

Two years after Lower's first experiments, on 15 June 1667, Jean Baptiste Denys, physician to Louis XIV, successfully transfused nine ounces of blood from the carotid artery of a sheep into the vein of a young man. This was followed by further transfusions in humans by Denys and also by Lower in England. Calves, sheep, dogs and horses were used, with many successful results. A great controversy soon arose. The protagonists of transfusion claimed that it was a panacea, curing all diseases, restoring youth and vigour and prolonging life. Its opponents, on the other hand, insisted that it was a dangerous practice and forecast that horns would grow on the heads of those transfused with ram's blood.

This controversy reached its climax in 1668, when an insane man died following a transfusion carried out by Denys. This resulted in the sentence of a French court prohibiting transfusion except with the sanction of the Paris Faculty of Medicine. This was followed by a ban in Rome, and for the next 150 years very little interest was taken in the possibility of blood transfusion.

In 1818, James Blundell, a lecturer in midwifery in Guy's and St Thomas's Hospitals in London, revived the subject by his researches into the effects of haemorrhage and transfusions in animals and man. He was appalled by the number of deaths, especially after childbirth, due to severe haemorrhage, and resolved to attempt the replacement of the lost blood by transfusion from a healthy human being. He evolved a rather crude apparatus whereby the blood could be collected into a receptacle and then injected into the patient's vein by means of a syringe.

As a result of Blundell's experiments, published in 1824, a great impetus was given to the subject of blood transfusion. By the end of the last century, many hundreds of cases had been treated and in about half of them successful results had been obtained. Many improvements had been made in Blundell's original apparatus, with a view mainly of eliminating the two possible sources of failure which were then recognized. These were the presence of air bubbles, and the introduction of small fragments of clotted blood, either of which results in the blocking of one or more of the arteries of the patient. One method devised in order to avoid these possibilities was that of direct transfusion introduced by Crile of America at the beginning of this century. In this, a vein of the patient to be transfused (the recipient) was connected with an artery of the donor. Blood then flowed directly from the latter to the former without leaving its natural vessels, so that the chances of clotting or of the introduction of air bubbles were minimal.

This, however, was not a very practicable technique for several reasons. In the first place, it was not possible to measure the amount of blood being transfused. Secondly, it involved a minor surgical operation on both recipient and donor in order effectively to expose the appropriate vessels. The donor's artery had to be permanently closed after the transfusion so that the same donor could not very well be submitted to the operation more than once or twice. Another important drawback in this method of direct transfusion was the psychological effect on the donor who had to be in such intimate contact with a very sick patient. Certain, though not all, of these objections were overcome by using a short tube to connect the blood vessels of recipient and donor. If the lining of these tubes were very smooth, clotting was prevented. Some workers used metal tubes lined with paraffin wax, while others used arteries of animals with their remarkable smooth natural lining.

A later development was a semi-direct method which followed on the introduction into medicine of the syringe and intravenous needle. Many varieties of apparatus were devised, all, however, based on the same principle. A hollow needle was inserted into the vein of the donor and another into that of the recipient—no further operation such as cutting the skin was necessary. The needles were connected to a syringe and, by turning suitable taps, it was possible to withdraw measured quantities of blood from the donor and inject them into the recipient. Again, certain disadvantages are present in these semi-direct methods; it is necessary, for example, for the donor to lie close to the recipient and know that his blood is flowing straight from his body into that of the sick man. But the semi-direct method is still used in many hospitals, especially abroad.

The most usual method of transfusion in this country is the indirect method. This depends on the addition to the blood of some substance to prevent clotting. In this way, the donor's blood may be collected by simple blood-letting, the anticoagulant added and the blood then taken to the ward for injection into the patient. The commonest anti-coagulant used is a simple salt, sodium citrate, which produces no harmful effects in the patient. It was first used by Hustin and by Lewisohn in 1914 and 1915, and its efficacy was thoroughly proved by the thousands of successful transfusions carried out during the Great War.

Apart from the avoidance of the introduction of air bubbles and clots, there are other important precautions which have to be taken in transfusing blood. One is that of ensuring that the donor is not suffering from any transmissible disease. It is of course clear that blood will not be taken from anyone suffering from an obvious infection. But in certain chronic diseases, notably syphilis, it is possible for there to be no apparent sign of the disease, although the blood remains highly infectious. Fortunately it is possible, by a rather elaborate technique, to determine whether the pro-

posed donor is syphilitic, and this test is always performed as a matter of routine.

In addition to the transmission of infective disease it is possible to transmit to the recipient certain hypersensitive conditions. A case is on record where a woman was transfused with the blood of an individual, who, although otherwise quite healthy, happened to be sensitive to strawberries. Since then, the patient is unable to eat strawberries without suffering from severe sickness and a violent irritating rash all over the body.

We have so far not discussed one most important source of undesirable and often fatal result in blood transfusion. It had been noticed from the earliest days of transfusion that the recipient frequently developed a high temperature, jaundice, the passage of blood in the urine and often heart failure, collapse and death. It was noticed that this was more likely with animal blood, but even when human blood was used these side effects still occurred in about half the cases. In 1900, an Austrian investigator, Karl Landsteiner, discovered that the blood plasma of one individual frequently caused the red blood cells of a second to clump together ("agglutinate") and later break up and liberate their haemoglobin pigment ("haemolyse"). The clumps of cells tend to lodge in the smaller blood vessels and block them so that the blood flow to vital parts of the body is cut off. If the patient recovers from this, the liberated haemoglobin pigment tends gradually to come out of solution in the minute filtering tubules of the kidneys, and these organs cannot then carry out their important function of ridding the body of its constantly accumulating toxic products.

Naturally, it would be of great value if it were possible to test the blood of the proposed donor before the transfusion to determine whether these complications would or would not ensue. Landsteiner's later work showed that this could in fact be done. He was able to demonstrate that all persons may be put into one or other of four different groups. It is not necessary to describe the details of these here. It will suffice for the moment if we remember that by determining the group to which the patient belongs—technically a fairly simple procedure—we can then choose a donor whose corpuscles will not be agglutinated by the plasma of the patient. The donor must be of the same group as the recipient or in certain circumstances of one of the other groups which the grouping tests show is "compatible".

It is a remarkable fact that this knowledge of the blood groups in man lay almost unnoticed for more than a decade. Landsteiner himself had pointed out that the presence of the blood groups in man was not of academic interest only but was of fundamental practical importance in the selection of appropriate donors for blood transfusion. But it was not until 1914, when the Great War raised the problem of blood transfusion acutely, that routine tests of blood groups began to be carried out.

With all the precautions now adopted before and during the transfusing of blood, serious accidents are extremely rare. Countless lives are saved each year by blood transfusions. But many more might be saved if it were not necessary to waste precious time in getting in touch with an appropriate donor. Every hospital has the names and addresses of volunteer donors whose blood group is known, so that it is possible for a suitable donor to be got to the hospital within quite a short time. In many cases, this is sufficiently rapid, but it frequently happens, particularly after accidents, that the need for a blood transfusion is urgent and a few minutes' delay may mean the death of the patient. A great deal of work has recently been devoted to the development of methods designed to eliminate all unnecessary delay in obtaining and transfusing the blood. It has been found, largely through the work of Professor S. S. Yudin of Moscow, that it is possible to store blood for a few weeks after it has been collected by keeping it in an appropriate anti-coagulant solution in a refrigerator. Such stores of blood, or

"blood banks", are now made throughout the world and have been begun in this country in the Manchester Royal Infirmary and other hospitals.

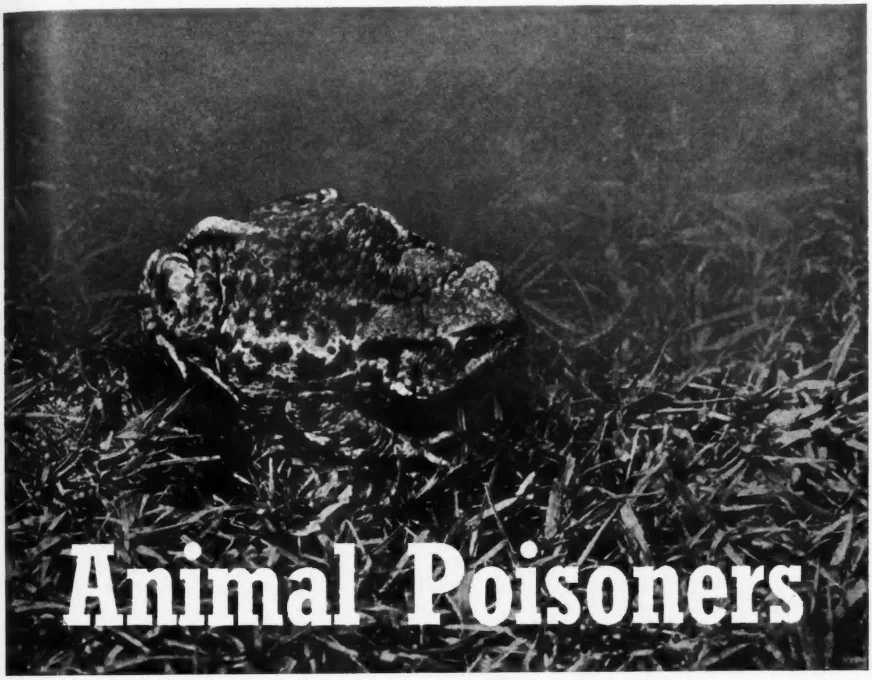
Three sources of blood for storage have been used. The most obvious of course is to collect the blood from the usual voluntary donors. This method was adopted in Spain during the Civil War and proved very successful. Blood was collected regularly from several thousand donors and grouped, tested and stored as we have described. The recently organized Emergency Blood Transfusion Service in this country is being run on similar lines to provide a rapidly available store of blood in an emergency. Volunteers are now being grouped so that at an outbreak of hostilities it will be possible at once to begin the formation of blood banks throughout the country. The blood will be collected, stored and carefully tested from time to time, for, in spite of the most careful aseptic technique during collection and storage, occasional bacterial contamination cannot be avoided.

Apart from donors, other ingenious sources of blood have been adopted, in which use is made of blood which would otherwise be wasted. One such source is the blood which is left in the placenta or after-birth, when it is detached from the newly-born infant. About one-sixth of a pint of blood can readily be obtained from each placenta and obviously without the slightest harm to either the mother or the child, since it is normally discarded with the placenta. It has been claimed that in a large general hospital, sufficient blood can be obtained from the maternity wards to supply the needs of the whole hospital.

A more gruesome source of blood supply is from people dying of accidents. The method was first utilized by Professor Yudin in the large Moscow General Hospital, where some 10,000 emergency cases are admitted annually. Many patients are brought in dead or dying from street accidents. As much as four or five pints may be obtained after death, and this can be grouped, tested and stored for a week or two just like fresh blood. Several thousands of transfusions with such blood have now been carried out in Moscow and with very good results (see *Discovery*, Notes of the Month, January 1939).

With these methods of using stored blood, one enormous advantage over the ordinary routine is that much greater quantities of blood are available for transfusion. One patient in Barcelona during the Spanish Civil War received a total of eighty pints of blood collected from ninety-six donors during sixteen transfusions. With the use of such large quantities of blood, the method of transfusion by means of a syringe is being replaced by others which are less laborious and ensure a smoother flow. One method is simply to allow the blood gradually to flow by the action of gravity into a vein from a vessel suspended above the patient. Another is a very recently described small rotary pump which is capable of maintaining a slow and continuous flow.

We have so far considered blood transfusion solely from the point of view of the recipient—the patient receiving the blood. What about the donor? It is customary to look upon the process of parting with a few ounces of blood as an act of extreme heroism. The popular press always acclaims the bravery of the man who has actually given, or even offered, his blood to save the life of his son or mother or fiancée. And yet it is not very long ago that as much blood or more was lost by "letting" or bleeding for the treatment of almost any complaint. The loss of a pint of blood may cause at most a feeling of faintness which passes off very rapidly. The body of a healthy donor is readily capable of regenerating this blood: some donors have given a pint or more repeatedly at intervals of a few weeks with no ill-effects whatsoever.



Animal Poisoners

by H. Chapman Pincher

A LARGE number of animals are characterized by their power of producing chemical substances which prove poisonous to other animals. A distinction must be drawn between *true* poisoning as the result of some inanimate chemical, and *concomitant* poisoning due to the accidental introduction of pathogenic germs into the tissues of a victim at the time of infliction of a wound. A bite from any carnivorous animal is likely to lead to some measure of concomitant poisoning, and we shall concern ourselves here only with those animals which owe their poisonous nature to the production of definite substances. Such substances are very diverse as to their chemical nature, being usually mixtures of complex organic compounds. They are equally diverse with respect to the type of organ producing them.

At the outset we may distinguish between poisonous chemicals produced as by-products in the general life (metabolism) o the animal and poisonous chemicals produced by special glands.

Poisonous chemicals produced in general metabolism

Many internal parasites produce chemicals as excretory products which find their way into the tissues of the host and cause poisoning. Some parasites destroy the actual tissues of their host and cause damage and perhaps death in this manner, but the majority are passive in this respect and owe their pathogenic nature almost entirely to the chemicals or "toxins" which they produce as by-products of their metabolism. Thus the distressing symptoms of malaria are due to the excretory products

produced and set free at intervals by the parasites causing the disease. The common tapeworm affects its host very slightly as far as the amount of food it absorbs is concerned, but its excretory products which are absorbed into the blood of the host may cause serious effects. The toxins produced by the bacterium *Bacillus botulinus* are so poisonous to man that consumption of canned food, which sometimes contains the toxins, results in a disease with an 80% mortality rate.

The flesh of many animals is permeated with chemicals which prove poisonous to other organisms eating the flesh. In this manner some tropical fish, such as the toad fishes and puffer fishes, are fatal to man, so much so that the Muki Muki of Hawaii, and the Japanese Fugu have often been used to effect suicide. This method, however, is not recommended, for as in the case of most animal poisons the symptoms are very terrible, death in this case resulting from paralysis of the heart and respiratory muscles after a long series of convulsions. There is no known antidote. Arctic explorers have found that the flesh of the Greenland shark is mildly poisonous to dogs, producing an intoxication similar to that produced by alcohol. The similarity is carried further by the fact that the dogs become less susceptible after repeated doses of the flesh. Some fishes, such as wrasse and parrot fish, are poisonous only at certain times of the year, this periodicity being in some cases due to the consumption by the fish of a particular type of food containing the poison, the fishes concerned being, of course, immune from the poison. In other cases, the poisonous nature of the flesh has some connexion with the breeding season. The ovaries of the barbel (*Barbus fluviatilis*) are poisonous and cause an intestinal disease known as barbel cholera in northern Europe where the barbel is commonly eaten. The ovaries of sea-urchins are also poisonous during the breeding season. In other animals the poison is restricted to organs other than the ovaries. Thus the livers of some Arctic animals are said to be poisonous. The blood of eels is also poisonous, but the dangerous principle is destroyed by the gastric juice of animals consuming eels.

Cases of poisoning in man as a result of eating mussels and oysters are common. There is no doubt that some of these are due to the special sensitivity of certain people to the flesh of shellfish, but cases are known where no such sensitivity or *allergy*, as it is known, is present. The symptoms of the poisoning are mainly paralytic. At one time it was thought to be due to the absorption of copper by the shellfish, but a poisonous alkaloid has since been obtained from apparently healthy mussels. The presence of the poison in some mussels and its absence in others remains a mystery. It has no connexion with spawning.

In the cases so far mentioned, the production of poison is of little if any advantage to the animal producing it. In fact, in the case of internal parasites, it may prove disadvantageous by killing the host. In those instances where the flesh is poisonous, it may have some survival value to the race as a whole, but no advantage accrues to the individual which must die to prove the efficacy of its product.

Poisonous chemicals produced by special glands

In cases where the poison is produced in special glands some benefit does usually accrue to the host. Here again the material to be discussed may be divided into two categories:

(1) Poison glands with no mechanical device for introducing the poison into the tissues of the victim.

(2) Poison glands possessing such a device.

The first type is best exemplified by certain amphibians, of which no better example could be chosen than our common toad. The toad produces two poisons, a *mucous poison*, secreted over the whole surface of the body by small mucous glands, and a *granular poison*, secreted by glands of

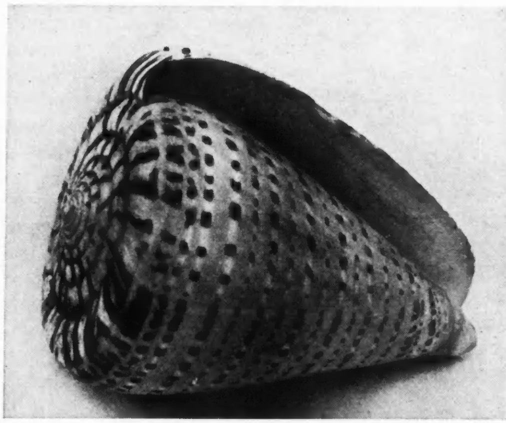
restricted distribution. The mucous poison is usually small in amount and therefore of little consequence, though it has definitely poisonous properties, fatally paralysing vertebrates if introduced into their blood in sufficient amounts. The granular poison, on the other hand, is both plentiful and powerful. The glands producing it are restricted to the "warts" on the skin and to the so-called *parotid glands*, which are swellings one behind each eye, as shown in the photograph. The poison, which is creamy and acid, containing two toxic principles, is ejected from the glands by the action of special muscles, but this ejection occurs only under great provocation. The poison is very potent and a sufficiency will kill any vertebrate. It is said that the poison from about ten toads would provide a fatal dose for a man. The poison has no effect on the skin unless an abrasion is present, but it irritates mucous membranes sufficiently for an animal such as a dog to drop a toad very quickly from its mouth. It is very lethal to frogs. A student recently brought in a vasculum containing about twenty toads and four frogs. After a short sojourn among the mucus secreted by the toads, all the frogs were dead. If swallowed, the poison is not destroyed by the intestinal juices and, moreover, is quickly absorbed into the blood stream where it may cause heart failure. As is to be expected, the toad is immune from its own poison, but very strong doses will kill it.

The poison must have some protective value, but unfortunately for the toad, its worst enemy, the grass snake, is immune from the poison.

Certain tropical amphibians produce a very potent poison. That produced by the beautiful tree frogs, *Dendrobates*, is so powerful that it is used by the natives of Colombia, in South America, for poisoning their arrows, these being used in killing monkeys for food. One frog contains sufficient poison to tip fifty arrows.

In this category must also be placed certain spiders and caterpillars which possess hairs containing an irritant fluid. This may be sufficiently strong to set up a severe inflammation of the human skin by mere contact.

A poison gland equipped with a mechanism for introducing the secretion *into* the tissues of a victim will obviously be more effective than the types just described, not only in defence but also in offence if needs be. The simplest instance of such a mechanism is provided by those animals, relatively few in number, which produce a toxic mucus in the mouth, this poison being introduced at the time of a bite. The Moray eel, common in warm seas, possesses numerous sharp teeth on the jaws and palate. These are bathed with toxic mucus



Specimen of a shell of Conus

which results in a bite which is both painful and difficult to heal. The toxicity of the mucus is doubtless quite fortuitous, but nevertheless of survival value.

In more complicated devices the glands are provided with special structures which usually serve no other purpose than the introduction of the venom. These structures are of two types, classified according to their position. If they are connected with the mouth they are termed *fangs*. If unconnected with the mouth they are known as *stings*.

Fangs of simple but efficient structure are present in spiders. The particular mouthparts adapted for the purpose are called *chelicerae*. Fig. 1 shows a single chelicera cut open to show the poison gland and poison duct. Not all spiders are venomous

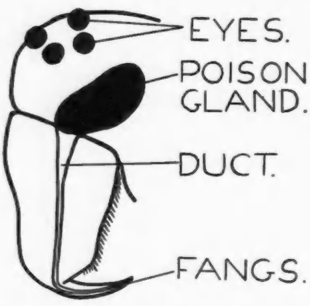


Fig. 1. *Single chelicera of spider*

as is commonly supposed, but the majority possess poison glands. The fangs make the wound and the poison is squirted into the incision by contraction of the muscles covering the poison gland. This expulsion is probably not a reflex action but under the control of the will, so that it is possible for a spider to strike without injecting any poison. The effects of a bite depend upon the amount of poison in the glands at the time, but usually the venom is fatal to the animal attacked. Small insects quickly succumb, but the rapidity of death seems to be due to the point of insertion of the poison rather than to the concentration. Fabre carried out experiments with the Tarantula spider, and found that the instantaneous death of bees and wasps was due to the fact that the spider always struck at the junction of the head and thorax. If the spider were made to strike at some other point, death did not occur for several hours. Large spiders can kill fish, small birds and small mammals such as mice and shrews. The bite of the Tarantula is probably never fatal to man, apart from deaths due to concomitant blood poisoning. No British spider can cause more than a slight irritation, but some foreign spiders, such as the black widow (*Latrodectus*), have a deservedly bad reputation. The black widow is found in the United States, France, Italy and Russia. It rarely exceeds half an inch in length. Only the female is venomous as far as man is concerned, the fangs of the much smaller male being unable to pierce the human skin. The venom, unlike that of most spiders, does not act locally but is rapidly absorbed into the blood stream and affects the whole system, destroying the red corpuscles and coagulating the fibrin in the plasma. The extract from a single female black widow is said to be sufficient to kill a thousand cats.

Similar in structure to the poisonous fangs of spiders are the poison claws of centipedes. The claws lie just below the mouth and are provided with large glands secreting a poison which is conveyed by a duct to an opening near the point of each claw. The poison produced by our native centipede (*Lithobius*) instantly kills worms, flies and other centipedes. That produced by the larger tropical types such as *Scolopendra* is extremely virulent, in some cases being fatal to man.

The only genus of molluscs possessing a poisonous mechanism is *Conus*, of which there is a great number of species common in all tropical seas. The shells of these species are very beautiful and commonly used as ornaments (see photograph). The teeth of the radula, which is a file-like structure, are barbed and provided with a poison gland as shown in Fig. 2. These molluscs are held in great awe by natives of tropical shores, but in all probability a bite, though severe, never proves fatal.

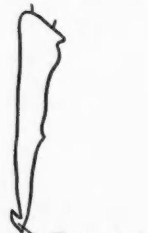


Fig. 2. *Single tooth of radula of Conus*

The most highly developed mechanisms for the injection of poison into wounds are encountered in snakes, where both the infliction of the wound and the insertion of

the poison are carried out by certain teeth. The poison is produced by modified salivary glands and the saliva of all snakes is toxic to some extent, though only about one-third of the 2300 recognized species of snakes is considered poisonous as far as man is concerned. The two poison glands are in connexion with one especially large pair of teeth, the fangs, which may be situated either at the back or at the front of the upper jaw. If they are situated at the back, the fangs are grooved on their front edges, the venom flowing down these grooves from the poison glands. If the fangs are situated at the front of the mouth, they may be grooved as in the cobras, or hollow as in the vipers. In some snakes these anterior fangs are very long and can be bent backwards out of the way when not in use. Moreover, in such types the maxillary bone to which the fangs are attached is hinged in such a manner that the points of the fangs can be thrown forwards when the animal is striking, a most efficient method. The apparatus found in the rattlesnake is shown in semi-diagrammatic form in Fig. 3. As a result of the erection of the fangs, the poison glands are squeezed by contraction of a surrounding layer of muscle, and venom is introduced into the subcutaneous tissues of the victim, whence it is absorbed into the blood and lymphatic systems. The venom is a straw-coloured or colourless liquid and contains two toxic principles, *neurotoxin*, which attacks the nervous system of the victim, and *haemorrhagin*, which affects the blood system. All snake venoms possess these two components, the proportions of which determine the main effects of the bite. If the neurotoxins predominate, paralysis results. If the haemorrhagins predominate, the red blood cells are dissolved and the blood coagulated. Neurotoxic venom is the most dangerous to man because of its extremely swift action, but if a victim does survive, general recovery is rapid, whereas in the case of haemorrhagins, although these produce little or no paralysis, the symptoms are prolonged and gangrene is likely to set in and cause death months after the actual bite. Gangrene is a common concomitant, since the haemorrhagins lower the power of the blood to resist bacterial infection. Cobras and mambas are examples of snakes with a preponderance of neurotoxic principle in their venom. The poison of vipers and rattlesnakes is mainly haemorrhagic in action.

Snakes are not poisoned by their own venom when swallowing poisoned prey since the poison is destroyed by the gastric juices.

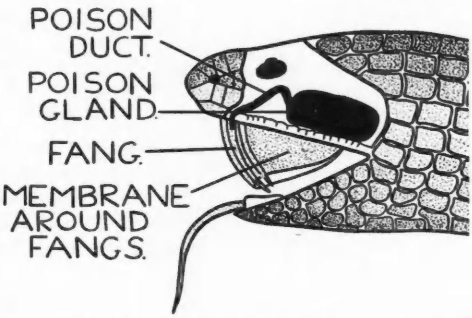


Fig. 3. *Head of rattlesnake dissected to show poison apparatus* (*diagrammatic*)

Apart from the snakes, poisonous organs in reptiles are confined to a single genus of lizards, *Heloderma*, the two species, *H. horridum* (Central Mexico) and *H. suspectum* (U.S.A.), being known as gila monsters. They attain a length of about 2 ft. The fang-like teeth are grooved on their anterior and posterior surfaces and are supplied with a poison, which, though very virulent in the case of small animals, is rarely fatal to man. Since these lizards feed on birds' eggs, the poison must have a purely defensive function.

The so-called horned toads (*Phrynosoma*) are in reality lizards and are often accorded poisonous properties. They are capable of squirting a fine spray of blood from the eyes, and though this is sour and unpleasant it is not poisonous.

The different types of poison organs met with under the name of "sting" may be small in relative size and large in number, or large in relative size and small in number. The best example of the former type is that known as the *nematocyst*, typical of the group of invertebrates known as the Coelenterata and including the jelly fishes, corals and sea anemones. They have been extensively studied in the polyp, *Hydra*, and will be described for that animal. Each nematocyst is an oval cell with a greater diameter of about 0·02 mm. They are situated over the general surface of the body of the polyp and are particularly numerous on the tentacles. As shown in Fig. 4, each nematocyst is hollow and continued into a long thread which is barbed at the base and bears a number of small spines. A sensitive spine is situated on an outgrowth of the wall near the base of the thread. At first, the thread is coiled

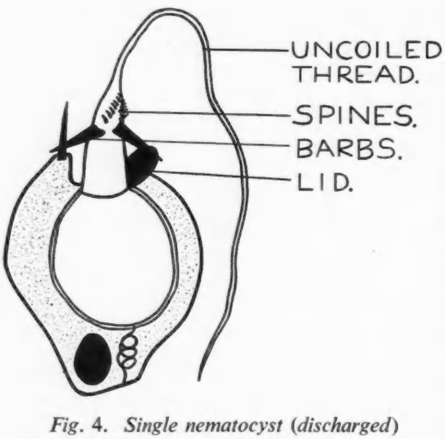


Fig. 4. Single nematocyst (discharged)

up in the cell as indicated in Fig. 5, the opening into the hollow of the thread being closed by a lid. If the sensitive spine is stimulated by contact with a passing animal, such as a water-flea, a special layer surrounding the hollow of the ceil contracts and exerts pressure on a liquid contained in the hollow, so that the lid opens and the thread is violently discharged. A coiled thread called the lasso probably serves to prevent the thread from leaving the nematocyst altogether. As the thread is discharged the barbs are the first to emerge and present their sharp points to the skin of the victim making an incision

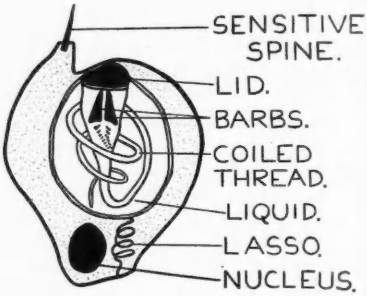


Fig. 5. Single nematocyst (undischarged)

which is widened as the thread is further expelled and the barbs turn away from each other. The ultimate result is the entry of the whole thread into the victim and the passage of the fluid from the hollow of the nematocyst through the perforated tip of the thread into its tissues. The fluid is poisonous and has a fatal effect on small animals.

Hydra possesses three other types of nematocyst differing in form and function, but the type described is the commonest and most effective. After capture by the nematocysts, the prey is pushed into the mouth of the polyp by the tentacles.

Nematocysts similar in structure to those of *Hydra* are typical of jelly fishes, in which animals they are commonly very powerful and capable of killing quite large fish. A sting from a Portuguese man-o'-war has been known to be fatal to man and results in the most excruciating agony when the poison is simply applied to the human skin.

Nematocysts exactly similar to those of coelenterates are found in certain nudibranch molluscs called aeolids (Fig. 6). These nematocysts are confined to certain outgrowths called *cerata*, which are in

direct continuity internally with the alimentary canal and externally with the exterior. The nematocysts are actually

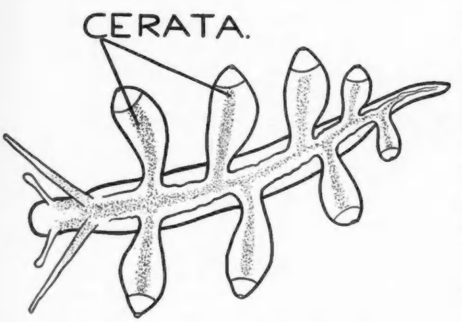


Fig 6. Specimen of Aeolis showing cerata

those belonging to anemones and other coelenterates on which the aeolids have been feeding. Somehow the nematocysts escape digestion within the mollusc and pass into the tips of the cerata, where they doubtless serve a defensive function.

Bodies similar in structure and function to coelenterate nematocysts are known in some free-living flatworms and certain nemertine worms. Structures resembling nematocysts and known as *polar capsules* are found in certain protozoan parasites, but it is doubtful if they are poisonous organs. More probably they merely serve to anchor the parasite to the lining of the host's intestine.

Another type of small poisonous organ present in large numbers is found in the sea-urchins. Each organ, known as a *pedicellaria* is simply a projection of the skin modified to serve a certain function. There are several different types of pedicellariae each with different functions, but only one type is poisonous, the so-called "gemmiform" type. Each gemmiform pedicellaria, as shown in Fig. 7, consists of a stalk bearing three globose jaws. Each jaw contains a poison gland, the duct of which opens at the base of the spine forming the apex of the jaw. When a sea-urchin is attacked by its usual enemy, the starfish, the spines of the sea-urchin are directed away and expose the pedicellariae, the jaws of which gape open. Contact of the tube feet of the starfish with the sensory papillae of any one of the jaws causes all the jaws to snap together, wounding the tissues of the attacking animal and allowing the entry of poison. As a rule some pedicellariae are pulled off each time the starfish retreats, so that finally the sea-urchin may lose all its defensive weapons and succumb.

Large poisonous organs are met with in a number of fish species. Best known of these amongst the bony fishes are the weevers (*Trachinus*) of our own shores, the poison organs of which are sufficiently powerful to warrant the erection of notices warning bathers of the presence of these fishes. That their poisonous properties have been known for a long time is indicated by their name which is derived from the Old English word meaning "viper". Both species of *Trachinus* possess poison glands in relation to a spine on each gill cover and to the five spines forming the rays of the anterior dorsal fin (Fig. 8). Each spine is grooved along the upper and lower edges,

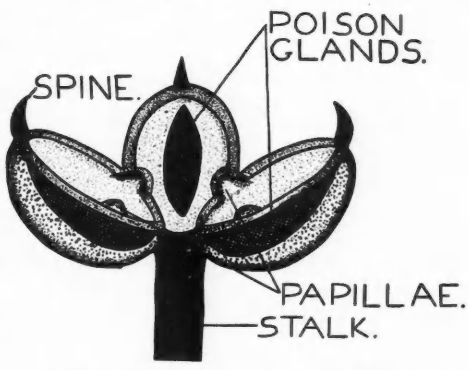


Fig. 7. Single gemmiform pedicellaria (expanded)

and surrounding these grooves are the poison glands which possess no ducts but

secrete their venom directly into the grooves. A wound is made by the spines and poison enters as a result of pressure on

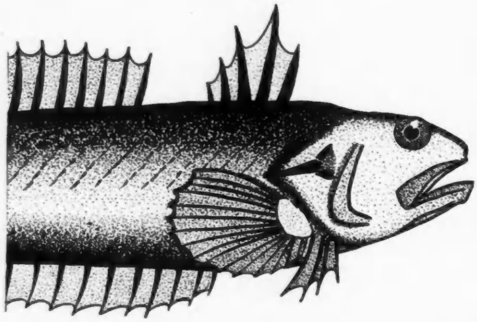


Fig. 8. Forepart of Weever showing poison spines

the glands. The venom is very virulent, the symptoms in the case of the human subject being stabbing pain, increased heart beat, delirium and sometimes even heart failure.

Similar structures occur in certain starfish of North American rivers. In the poison toad fishes (*Thallassophryne*), the spines are hollow and perforated after the manner of a snake's fangs.

Poisonous organs are more widespread in cartilaginous fishes than in bony fishes. *Trygon*, the sting ray, is particularly notorious, the grooves of its terrible serrated spine being fed with the secretion of poison glands of such virulence as to prove fatal to man on occasion. The spiny dogfish, eagle rays and bull-headed sharks have a deservedly bad reputation amongst fishermen.

In all fishes it appears that the poison organs are used exclusively for defence. Even in the poison toad fishes, which possess the most elaborate mechanism, this must be the case, for their food consists entirely of small molluscs and crustaceans.

A very effective single sting is possessed by the scorpions, where it is situated in the last segment of the body. There are two poison glands, the two ducts uniting to form a single tube opening just in front of the point of the sting. The sting is used only on large prey in attack and only under great provocation in defence. At the moment of the strike muscles squeeze the poison glands and cause the ejection of the fluid, which is much more virulent than that of spiders. It is instantaneously fatal to small animals, and some African species are dangerous to man, causing nausea, vomiting and convulsions. The scorpion is quite immune from its own poison, so that tales of its committing suicide when threatened by fire are ill-founded.

The highest development of the sting is encountered in the insects, of which the sting of the female honey bee may be regarded as typical. As shown in Fig. 9, the sting is composed of three separate pieces, a dorsal *stylet sheath* and a pair of *stylets*. The stylet sheath is expanded to form the bulb of the sting and in addition bears two guide rails as shown in the section (Fig. 10). The guide rails fit into two grooves on the stylets so that these can move up and down in the stylet sheath. The venom is produced by three glands, a pair of acid glands and a single alkaline gland,

Fig. 9. Sting of Honey Bee (semi-diagrammatic)

the secretions of these mixing in the hollow bulb of the sting. The stylet sheath makes the actual wound in a victim. Each stylet bears a projection which serves as a piston,

pushing down any venom which has collected in the bulb into the poison canal and hence into the wound.

The poison has its full effect only when a mixture of the acid and alkaline elements is present. In certain insects where the alkaline gland is absent, the poison only stupefies the prey.

Certain insects, such as those of the genus *Pompilus*, grow to a length of 3 inches and can inflict a sting which may have serious results. *Pepsis*, an insect closely related to *Pompilus*, is so powerful as to be able to dispatch the enormous bird-eating spider, *Mygale avicularе*.

A poisonous insect famous in medieval days was the so-called Spanish blister fly, in reality a small green beetle. An extract of this insect produces blisters when placed on the human skin, 1/10,000th of a gram being sufficient to induce a blister. The blood was a common ingredient of alchemist's love potions, and in many cases must have resulted in very severe inflammation of the kidneys.

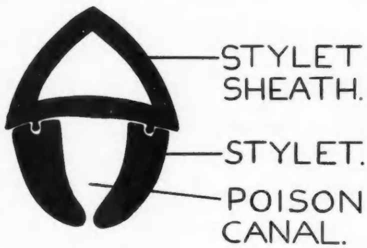


Fig. 10. *Section of lower part of sting of Honey Bee*

From this survey it will be realized that poisonous animals have a wide and sporadic distribution in the evolutionary table, and therefore we must assume that the capacity for poison production has arisen many times on widely different occasions in geological time. In very different animals, the poison organs show close similarity of form and function, but such similarity must be regarded simply as an example of convergence and no indication of relationship.

Separating Isotopes

By K. E. Grew

A NEW method is being developed for the separation of isotopes. Ever since Sir J. J. Thomson and Dr Aston at Cambridge showed that the atoms of the same element may not all be alike in mass, attempts have been made to separate the different types of atom, or isotopes as they are called.

This is difficult because in many respects one isotope behaves in exactly the same way as another. The isotopes of a particular element differ only in the mass of the nucleus of the atom. They are alike in the number and arrangement of electrons around the nucleus, and since it is this which determines the chemical behaviour, they are alike chemically. It is consequently not possible to separate isotopes by chemical methods: some property which depends on the mass must be used.

Several methods have been tried with

varying success. Until recently, in only one case, that of the isotopes of hydrogen of mass 1 and 2, had practically complete separation in appreciable quantity been effected. But here the conditions are altogether exceptionally favourable because of the large mass ratio of 2 : 1. In other cases it had been possible to do little more than bring about a small change in the relative proportions of the isotopes. Now a process is being evolved which, it is reported, has been successful in separating the isotopes of chlorine, and will no doubt soon be applied to other elements.

The basis of this method is an effect which was predicted by Professor Chapman from his theoretical work on gases and called by him thermal diffusion. Thermal diffusion has since been experimentally established and measured. Briefly it is this. Let us imagine two glass vessels joined together by a tube in which is a tap. The tap is closed and one vessel is filled with say hydrogen and the other with nitrogen, so that the pressure is the same in each. Now if the tap is opened we know that the hydrogen diffuses into the vessel which initially contained nitrogen, and the nitrogen diffuses into the vessel which initially contained hydrogen, until finally a uniform mixture is formed. This, however, only if the two vessels are at the same temperature. It was Professor Chapman's remarkable discovery that, if now one of the vessels is heated while the other is kept at a constant temperature, the gases tend to separate again. The lighter gas (in this case the hydrogen) accumulates in the hot vessel, the heavier (the nitrogen) in the cold one. This is thermal diffusion. Of course the separation is not complete, because all the time the process of ordinary diffusion is tending to mix the two gases.

Have we not here a method for separating isotopes? Not quite. The separation produced by thermal diffusion depends on the ratio of the masses of the gas molecules; it is small for isotopes because the mass ratio is small. The separation diminishes too as the proportions of the isotopes in the containers become more and more unequal. Something more was required. Clusius and Dickel solved the problem by supplementing the thermal diffusion process with a gravitational one. They placed the gas (say chlorine, which consists of two isotopes of mass 35 and 37) in a vertical tube down the centre of which was a wire heated electrically. There is a temperature difference between the gas near the wire and that near the walls. Two things happen. First, thermal diffusion occurs, the heavier isotope moving towards the walls, just as in the case of the connected vessels the heavier gas moves to the cold vessel. At the same time convection currents are set up in the gas: the gas near the wire, richer in the lighter isotope, moves upwards, that near the walls, richer in the heavier isotope, moves downwards. The result is that as this diffusion and circulation proceed the heavier isotope accumulates at the bottom of the tube, the lighter at the top. Clusius and Dickel announce that they have almost completely separated the isotopes of chlorine in this way.

Why is the separation of isotopes so interesting? The answer lies in what was said earlier, that the chemical behaviour of isotopes is similar, yet the isotopes may be distinguished by their difference in mass. The mass acts as a kind of label so that it is possible in a chemical reaction to trace the atom to its final destination. As an example, let us take an application to a biological problem—the transformation to which the poet (Mr Walter de la Mare) alludes when he says:

> It's a very odd thing,
> As odd as can be,
> That whatever Miss T. eats
> Turns into Miss T.

How do the different elements in Miss T.'s food become distributed through her body, and for how long do they remain there? These questions can be answered, at least in the case of smaller animals than Miss T., if the food is made to contain an abnormal proportion of an isotope of one or more of

the elements. A subsequent determination of the isotope proportions in the various parts of the body or its secretions will then indicate how this particular sample of food has been distributed. Experiments on these lines are going to solve many problems in chemistry and biology.

Notes of the Month

OXIDATION AND TARNISHING OF METALS

As mentioned in "Notes of the Month" for August last, the direct combination of dry air or oxygen with a metal often results in the formation of an oxide layer which prevents any further immediate access of oxygen to the metal. But even when such protective layers are formed, oxidation does continue, very slowly at room temperature and comparatively rapidly at high temperatures. The actual rate varies very widely from one metal to another.

It was originally supposed that this rate was governed by the speed at which *oxygen molecules* diffused *inwards* through the oxide layer prior to reacting with the underlying metal. Recently, however, Wagner has suggested that the *metallic atoms* or ions actually diffuse *outwards* through the oxide film, and there is definite experimental evidence in favour of this view. The oxide, or other protective film, has an ionic lattice, and the metallic atoms diffusing outwards are dissociated into positive ions and electrons. The diffusion of negative oxygen ions inwards may also occur, but is less likely, owing to the large size of oxygen ions. Since we are dealing with the movement of charged particles, it may be shown that the rate of diffusion, and therefore the rate of oxidation, is intimately connected with the electrical conductivity of the film substance. It is thus to be expected that oxides with a high electrical resistance, such as aluminium oxide, will confer good oxidation-resisting properties on the underlying metal, as is generally found to be the case. Wagner has also made detailed calculations of the velocities of a few simple reactions of this type, starting from the electrical conductivities and other independent data, and obtains reasonable agreement with the experimental values.

One of the reactions considered by Wagner is the formation of silver sulphide from silver and sulphur. This has an important bearing on the tarnishing of silver. As is well known, silver remains bright for a long period in pure air, but tarnishes quickly in an atmosphere containing H_2S or SO_2 (e.g. near an open fire, or a gas stove), or in contact with materials containing sulphur (eggs, indiarubber, etc.). The dark-coloured films formed on the surface of the metal are either entirely or partly composed of silver sulphide, according to the circumstances. Other lines of evidence show that the silver ions in silver sulphide can move about with exceptional ease, and this accounts for the rapidity with which silver tarnishes in the presence of even small traces of H_2S, and other sulphur compounds.

Price and Thomas have recently shown how these principles may be applied to the practical problem of lessening high-temperature oxidation and tarnishing. By heating alloys containing a small percentage

of aluminium in a mixture of water vapour and hydrogen, it is possible to form a thin, invisible layer of tarnish-resistant aluminium oxide on the surface without oxidizing the more noble constitutent of the alloy (copper or silver). After this treatment these alloys show a vastly improved resistance to attack. It is also possible to deposit oxide layers of this type by an electrolytic process.

J. N. A.

Wagner, Darmstadt;
Price and Thomas, Cambridge.

VERMICULITE: A NEW INSULATING MATERIAL

THE little known mineral vermiculite has recently come into prominence commercially. Vermiculite is a hydrated silicate of variable and complex chemical composition occurring in metamorphosed igneous rocks. It is known to be derived from the decomposition of certain micas.

For the insulation of houses a layer of vermiculite is laid on ceilings or held by cloth. It is also used mixed with different cements and binders to form plasters with acoustic properties. It is now realized that the high sound insulation qualities of certain light refractories produced in Australia are due to their vermiculite content. It is also being used as a substitute for asbestos in the lagging of large furnaces.

It can also be used in place of cork for lagging, where its lightness is a great advantage. A cubic foot of cork weighs between 9 and 10 lb., whereas some specimens of vermiculite weigh as little as $3\frac{1}{2}$ lb. per cu. ft.

In heat insulation a 2 in. layer of vermiculite is reported to reduce heat loss by 70 %, a 4 in. layer by 92 %.

Its increased use can be judged from recent figures issued by the U.S.A. Bureau of Mines. In 1936 only 16,733 tons were sold, whereas by 1937 this had risen nearly 50 % to 24,556 tons. The U.S.A. produces most of the world's vermiculite at the moment, though deposits in Russia and in the Transvaal are being opened up.

The mined rock containing a percentage of vermiculite is crushed in a hammer mill, and separated from impurities by screening. It is then heated for a matter of seconds at a temperature of 900–1000° C. This results in the mineral grains expanding, or exfoliating, to some 16 times their normal size. This results in the heated material having a cellular structure, with large air spaces, which are responsible for the remarkable insulating properties. W. E. D.

(*Science News Service.*)

SUSCEPTIBILITY TO ALCOHOL

ACCORDING to a recent report by Dr Nagle from California, it is now possible to test susceptibility to alcohol. The test is very simple. A small amount of alcohol is injected into the skin. Very soon afterwards a wheal develops which is followed by a red zone of inflammation. The area of this zone is apparently proportional to the sensitivity towards alcohol. 250 people were tested, and the intensity of their skin reaction fitted well with their own observations regarding their tolerance to alcohol. This was further confirmed on fifty of these persons, whose suceptibility was measured by giving them varying doses on an empty stomach. By this means, Dr Nagle classes people in six groups of alcohol sensitivity, ranging from extreme sensitivity to very considerable tolerance. It seems that there is one chance in five of

belonging to the hypersensitive group, in which case a quarter of an ounce of alcohol (that is, about a quarter of a pint of beer, one glass of sherry or a small whisky) will cause slight tipsiness. The chances of belonging to the insensitive or "immune" group is only one in ten. Those belonging to this group can take ten times this amount of alcohol before any signs of intoxication appear.

J. Y.

(*Nagle, California.*)

"MICRONUTRIENTS" AND PLANTS

RECENT experiments have shown that several elements, till lately considered unessential, must be present *in traces* in the soil if plants are to complete full and healthy growth. The classic "water-culture" experiments carried out by Sachs and Knop in the middle of the last century established that potassium, calcium, magnesium, iron, sulphur, phosphorus and nitrogen were essential. It is now known that the last three elements enter into the chemical composition of certain vital plant proteins, which cannot be built up in the absence of any one of these elements. Magnesium forms part of the chlorophyll molecule, and iron in small traces is necessary, for without it the plant is unable to build up chlorophyll. Views as to the part played by the other metallic elements are constantly being revised in the light of new developments of modern physical chemistry.

Following on the early work a complete culture solution (such as that known as Knop's solution) could be made of calcium nitrate, potassium hydrogen phosphate, magnesium sulphate, potassium chloride and a small trace of iron phosphate. Shive and Tottingham have been able to reduce the number of salts in a complete culture solution to three—potassium hydrogen phosphate, calcium nitrate and magnesium sulphate; with a trace of an iron salt. (Contrasted with Knop's solution this shows that chlorine is not an essential element.)

But attempts to grow plants in these solutions, containing all the elements, then considered essential, failed in certain cases, such as flax and tobacco. It was found that for perfect growth these plants needed a trace of boron.

Further experiments have shown that boron is one of the most important of these so-called "micronutrients" for a number of plants. It was discovered, for instance, by Warrington in England as long ago as 1923 that boron was necessary for the normal development of broad beans. Certain citrous fruits (notably oranges and lemons) both appear to need boron. On soil where these fruits develop poorly, producing but little juice, the addition of borax to the soil has been found to remedy this fault.

Experiments carried out at the Oregon Agricultural Experimental Station in America show further effects resulting from boron deficiency. According to Dr W. L. Powers of this station, "top sickness" of tobacco, "cork spot" of apples, "brown heart" of turnips, "yellow top" of alfalfa, and "crown rot" and "heart rot" of sugar beet can all be labelled as boron-deficiency diseases.

In Oregon boric acid applied at the rate of 30 lb. per acre is found to stop "yellow top" of alfalfa, and to increase the yield. In the field the normal colour of the plant is restored within 30 days, and in an even shorter time under the controlled conditions in greenhouses. (In "yellow top" the leaves at the top of the stem become thin and yellowish. The terminal bud and the blossoms assume a blighted look. Boric acid causes lush green growth, and vigorous branching of the stem. The chlorophyll content after boron treatment is calculated to be increased by 50 %.)

Other elements which can act as "micronutrients" towards certain plants include iodine, manganese, copper and zinc. The

grape fruit, for instance, shows a marked need for small amounts of zinc. In its absence the fruits are all skin and pith, while the addition of zinc salts to the soil results in natural growth. W. E. D.

(*Powers, Agricultural Experimental Station, Oregon, U.S.A.*)

TEMPERATURE AND INSECT ACTIVITY

THE behaviour of insects has long been known to vary with temperature, but it is not generally known that many of them have considerable control over their body temperature, though not to the same extent or in the same manner that warm-blooded animals do.

Ants are a clear example of insects whose habits are closely correlated with temperature. The rate of their activities is speeded by the heat of the sun, and they are essentially diurnal animals. In the winter, when the temperature is low, little activity goes on outside the ants' nest.

Hive-bees warm the hive above the temperature of the air outside by their combined muscular exertion, which creates a warm, heavy atmosphere suited to their needs. They can also cool the hive in hot weather, and in the summer it is a common sight to see a number of bees stationed near the entrance to the hive, continually vibrating their wings and creating a draught. Termites also keep the temperature of the nest regulated within narrow limits. In the more specialized species as found in Australia, they actually construct rectangular rounds, orientated so that the narrow ends always point north and south. This is believed to promote cooler conditions in the heat of the day. The termites are certainly known to retire to the lower parts of the "castle", which are better insulated against the heat, in the hottest hours.

At high temperatures insects above a certain size can keep themselves cool for short periods by evaporation of water from the body. At low temperatures, some insects can warm their bodies above the temperature of the surrounding air by the chemical changes in their katabolism, as in the case of bees, and all insects which are vigorous fliers. For the intense muscular effort of flight a high body temperature is essential. For instance the large Sphingid or Hawk-moths are unable to "take off" immediately from rest. They first stand with their wings vibrating, "shivering" as it appears, until the temperature in the thorax has risen above 30° C. Only then can they fly, and during flight the temperature will exceed 40° C. Similar changes occur in many other insects during activity, but whether insects *at rest* will increase their katabolic rate in order to maintain the body temperature is at present uncertain.

The enormous increase in the metabolic rate during flight may be 40 times that of the rate at rest (in bees and hawk-moths). In certain flies the increase is as much as 100 times, and this increased rate may be maintained for over 30 min. Human beings in a state of extreme exertion will increase the metabolic rate from 10 to 14 times that of the normal resting rate, but they can only maintain this for a few seconds at a time.

All these effects, whether in man or in insects, are measured by the amount of oxygen consumed and the amount of carbon dioxide given out, the ratio of these two being known as the respiratory quotient. In periods of greatest activity, this value is very nearly 1, in both flying insects and in man, though the insects achieve greater "efficiency" as they more nearly approach the value 1. (The value 1 would obtain when the oxidation of the glycogen of the muscles was complete, according to the equation

$$C_6H_{12}O_6 + 6O_2 = 6CO_2 + 6H_2O,$$

from which it is seen that a volume of car-

bon dioxide is produced equal to that of the oxygen consumed.)

The enormous oxygen uptake relative to their small body weight in flying insects is no doubt correlated with the fact that their flight muscles twitch very rapidly: 160–200 times a second in blowflies, and 300–400 times in some bees and wasps. The muscles of a trained man on the other hand, a deft pianist for example, cannot contract more than 10 times a second. R. A. DAVIS

SINCE the editorial in the September number, new results of research make it appear unlikely that the "uranium bomb" will be practicable for many years. The reason is roughly this: the nucleus which gives rise to progressive disintegrations seems to be not the ordinary uranium nucleus but that of a rare isotope. This isotope of uranium does not exist in sufficient quantities, so far as we know at present, to enable its particular type of disintegration to be used for practical purposes. Most people who know of the possibility are relieved that it has not turned out to be workable.

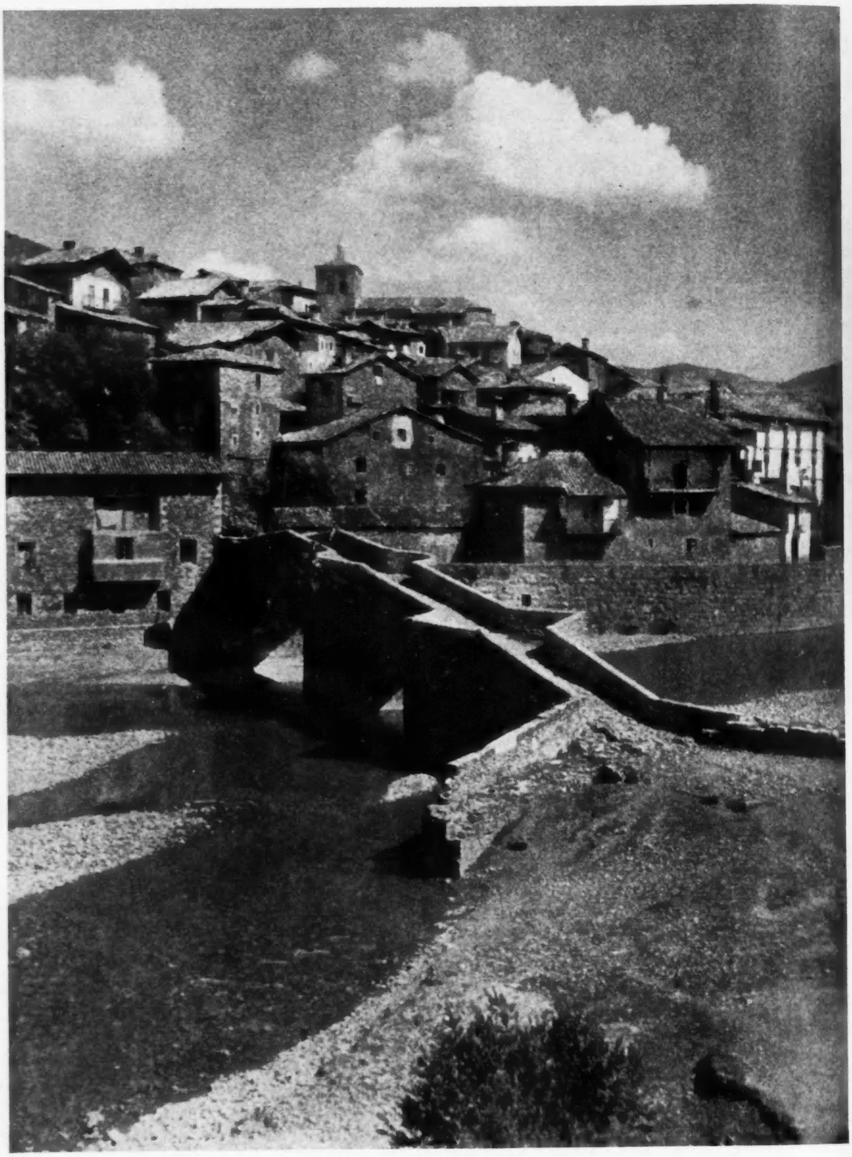
The Basques: The Oldest People in Europe

By RODNEY GALLOP

RECENT events in Spain have turned a tragic limelight on the Basques and have brought to them a notoriety which they could never have expected oF sought. Yet few of those who gave shelter to Basque refugee children or followed in their daily papers the vicissitudes of the Biscayan campaign have more than the faintest idea who the Basques are, whence they have come, what their language is, and what differentiates them from their French or Spanish neighbours. These questions, difficult to answer at the best of times, have been still further confused by the amount of nonsense which has been written on the subject, and, although science can throw light on many of its aspects, a veil of mystery still clings round the oldest race in Europe.

Until the end of the first millennium after Christ, little is heard of the Basques with the exception of a few vague and ill-authenticated references by Latin authors to a tribe known as the Vascones and distinguished from their neighbours by a language which, in Roman ears, was "barbarous and not to be borne". By the twelfth century the Latin name had given birth to the twin forms of Bascli or Basculi and Gasconi, from which are derived the modern appellations of Basques and Gascons. The name of the Basques for themselves in their own tongue is *Euskaldunak*, "those who possess the *euskara*" or Basque tongue. The root *eusk-* (and its Latin equivalent *vasc-*) is possibly connected with the Basque word *e(g)uzki*, meaning the sun. It would not be the first time that a race had called itself the People of the Sun.

As the curtain begins to rise on the Dark Ages mention is made by pilgrims to Santiago de Compostella and by other adventurous travellers, of a primitive people, straddling the Pyrenees, *qui n'entend de langage* (which understands no language), as the "Grande Chanson des Pèlerins" puts it. These people, the descendants of the *inquieti Vascones*, systematically pillaged all who came their way. St Leon, the first Bishop of Bayonne, met his death in the Pyrenees at the hands



The Navarrese village of Burgi

of "very cruel pirates and satellites of the Devil", and Giraldo, Canon of Compostella, described them in 1120 as "real savages as bloodthirsty and ferocious as the wild beasts with whom they live". The time was to come when Basque Catholic

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Basque farmstead at Sare

missionaries would give their lives for their faith, but in the Middle Ages they were content to make martyrs, not to furnish them, and the pilgrim Aimeric Picaud summed up the verdict of the age when he dubbed them "black, perfidious, faithless, corrupt, violent, savage, given over to drunkenness and evil-living".

For many centuries people were content to blackguard the Basques without giving any thought to their racial origins, and when at last enquiring minds began to approach the problem from a different angle, research passed in turn through three stages which, following Auguste Comte, may roughly be defined as the theological, the metaphysical and the positive.

The theological approach, which had its heyday in the eighteenth century, was characterized principally by a fixed and preconceived notion that Basque was the language spoken in the Garden of Eden, if not indeed in Paradise, as a Spanish Basque cleric set out to demonstrate in a pamphlet published as recently as 1910. This attractive theory was based on the usual ingenious etymologies. Dominique Lahetjuzan, for instance, proved conclusively that the name Adam was the Basque for "he who is full of understanding", while Eve was derived from *Ez-Ba* (no-yes) and thus commemorated woman's traditional privilege of changing her mind.

The first person to approach the problem from a more objective angle was the German savant Wilhelm von Humboldt, who reached the conclusion over a hundred years ago that the Basques were the last remnant of the Iberians, the primitive inhabitants of Spain, who had been driven by successive invasions to this remote corner of the Pyrenees, much as the ancient Britons were driven into the mountains of the west by the Romans, the Saxons and

Basque Farmers at Alava

the Danes. The number of Basque place-names scattered over southern France and Spain appeared to lend probability to this theory, and it has indeed more to recommend it than many others which were propounded in the nineteenth century linking up the Basques with Finns and Hungarians, with the Celtic peoples, with the tribes of the Caucasus, with the Indians of North, South and Central America and even with the Japanese. The writers of the "metaphysical" period were all treading the quicksands of linguistics, and it is only a few years since an English university published a book linking up Basque with the language of the ancient Minoans in a manner which could satisfy students of neither the one nor the other.

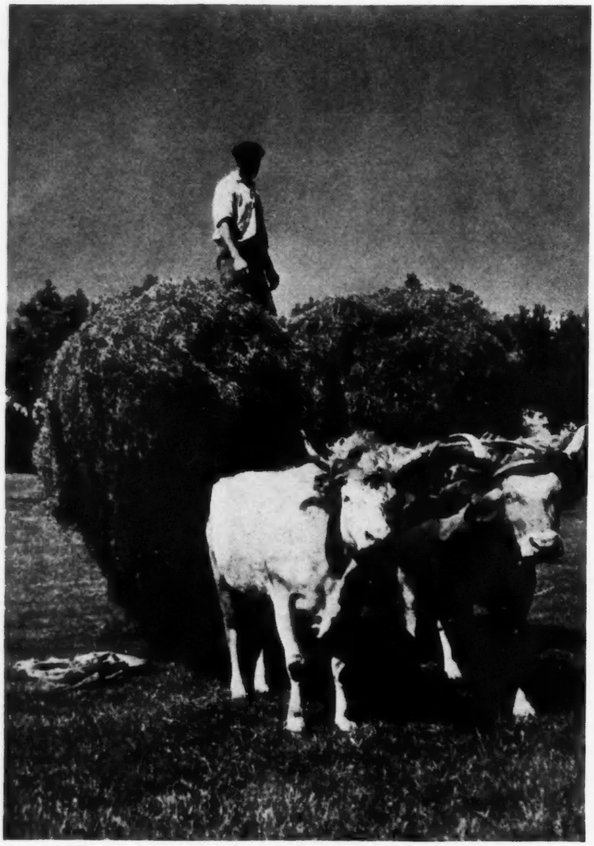
Even in the middle of the nineteenth century, however, there were minds which distrusted all these theories and inclined to the view that no connexion between the Basques and any other people of the known world could be taken for granted. Julien Vinson was the father of this "positivist" school, and the most recent investigations have tended to confirm his view that "from earliest times the Basques have never been more than a small tribe dwelling in a few valleys of the Western Pyrenees". Its confirmation has been based less on linguistics than on the fruits of archaeological and anthropological research associated particularly with the names of Bosch Gimpera, Aranzadi and Barandiarán. Archaeology has shown that from Palaeolithic times a uniform culture existed in an area of north-west Spain and south-west France somewhat larger than that at present inhabited by the Basques, while anthropology confirms that the skulls found on both Palaeolithic and Neolithic sites in this area correspond closely with a type which predominates among the

Navarrese Basques at Roncal

Basques of to-day and which is rarely found among the adjacent Spanish or French populations. This type lies between the brachycephalic and the dolichocephalic, and is distinguished by prominent temples, high cheek-bones, a narrow lower jaw, a long, pointed nose and a projecting chin. (The research on which these conclusions are based dates only from the last twenty years and has been interrupted by the Spanish Civil War, notably on the site of Urtiaga near Itziar in Guipúzcoa, opened up by Aranzadi and Barandiarán.)

How then may one account for the affinities between the Basque and the Iberian languages, as demonstrated in place-names and fragmentary inscriptions found almost all over Spain? The most plausible explanation is that when the very primitive and backward Pyrenean ancestors of the Basques came into contact with the relatively advanced civilization of the Iberians (who probably came to Spain from North Africa), they either adopted the language of the latter in its entirety or borrowed very largely from it.

Antiquity is stamped on the Basque language, both in its vocabulary and in its syntax. The appalling complexities of grammar and construction in which, for instance, the sex of the person addressed may be conveyed in the verb even if the latter is not in the second person, shows it to be the product of a type of mind foreign to any other in Europe. Again, the Basque words for most cutting instruments are derived from the root *aitz* meaning rock or flint, and thus seem to denote a Stone Age origin, while the names for Monday, Tuesday and Wednesday suggest that there was a time when the Basques had a three-day week. Incidentally, one Basque word at least has entered into English vernacular speech. The expression "by Jingo", which



The Hay Cart

is more than 250 years old, derives from *Jinkoa*, the word meaning "God" in the Soule dialect of Basque.

Of the antiquity and originality of the Basque stock there can therefore be no possible doubt, and it is doubtful whether its relationship to any other member of the human family will ever be demonstrably established. When we come to consider their customs and traditions, however, we must tread somewhat more cautiously. The visitor to the Basque country, whether on the French or on the Spanish side of the frontier, will be loosely told that Basque songs and dances, seasonal festivals, legends, decorative arts and superstitions are as original as they are unique. It is true that in all these spheres the Basque heritage to-day is distinct from that of their nearest neighbours. Béarn and Gascony, Aragon and Castile have little to show which can be compared with the *Pastorales* and *Mascarades* of Soule, the *Cavalcades* of Basse-Navarre, the Sword Dances of Vizcaya and Guipuzcoa, the discoidal tomb-stones, and the austere, modal folksongs. It does not follow, however, that they never possessed such things; rather the contrary. One of the most marked traits of Basque character is a profound conservatism. Slow to adopt Christianity, for instance, they are now the most fervent and tenacious Catholics in the whole Peninsula. The same holds good in the material sphere. A careful, comparative study of Basque traditional peasant art and lore reveals innumerable analogies with the common stock of European tradition which gives such astonishing unity to our continent. Vinson states roundly that "the Basques have nothing original, nothing exclusively their own save their language", and Camille Julian is going nearly as far when he writes that "each vanished age seems to have bequeathed to Basque civilization the heritage of at least one ineradicable custom".

No better example of this tendency can be quoted than the remarkable *Pastorales* of Soule.

Of the three French Basque provinces (which lost their administrative autonomy with the creation of the department of

Basses Pyrénées after the French Revolution) Soule is the farthest from the sea, the smallest, the most mountainous, and the least visited by tourists. Its highland villages are the scene in spring or early summer of theatrical representations which are a projection of the Middle Ages into the twentieth century. The *Pastorales* are dramas in verse, preserved in well-worn copy-books, and performed in the open air by farmers and village artisans with a repertoire and a stage technique recalling those of the medieval mystery plays. The themes are drawn from the Old Testament, the Lives of the Saints and early ecclesiastical history, the legends of classical antiquity, the *chansons de geste* and romances of chivalry, and more recent episodes of French history. The verses are not spoken but chanted, and the performers make no attempt to act naturalistically, but stride up and down the improvised stage of boards and trestles with a severely limited range of conventionalized gestures.

Most curious of all, they are divided, whatever the theme, into "Turks" and "Christians". The latter, in whose costumes the colour blue predominates, are the "good" people, that is to say the Israelites in *Abraham*, the Persians in *Astyage Roi de Perse* and the French in *Jeanne d'Arc* and in *Guillaume II ou la Campagne de France 1914–18*. The "Turks", who are dressed in scarlet with the tall headdresses of ritual dancers, are the enemy, whether they be, in the four abovementioned plays, the inhabitants of Sodom and Gomorrha, the Medes, the English or the Germans. "Turks" and "Christians" each have their separate stage entrance, and, whatever the plot, there are innumerable battles between them which are stylized to the point of being little more than country dances. The performance takes up most of the day, and in characteristic medieval fashion the female parts are played by men or boys.

This spectacle is unique in Europe to-day, yet a careful study of its origins shows it to be not an invention of the Basques but a fusion of two traditions, both widespread once, which have shrunk to-day almost to nothing. One of these traditions is that of the medieval stage with its Mysteries and Moralities and its obsession with the struggle between good and evil. The other, more localized in southern Europe, is that of the ceremonial combat of the Moors and Christians which may have developed originally out of our ritual battles between summer and winter, but which achieved its

The Sacristan of Beasain

present form and enjoyed far more than its present popularity at the time of the Crusades and of the reconquest of Spain from the infidel.

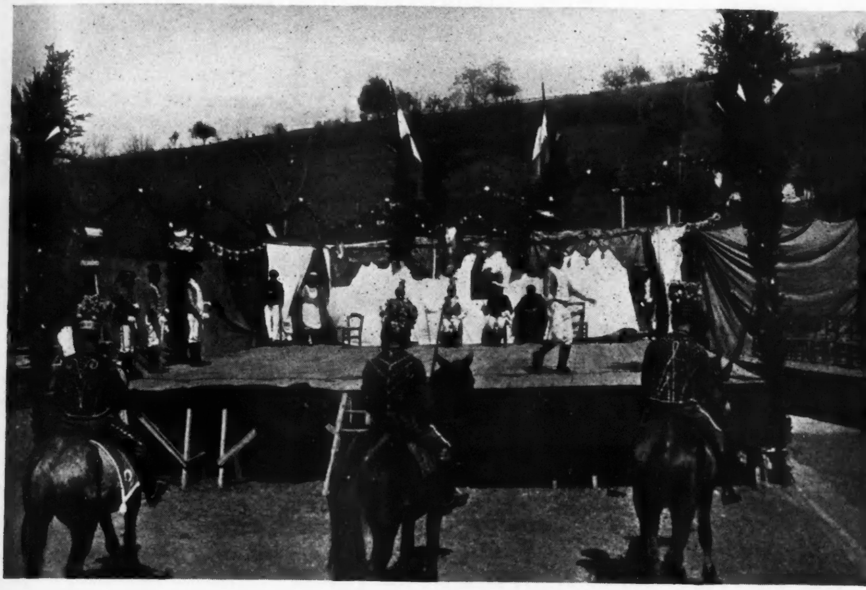
If it must regretfully be admitted that the Basques are lacking in creative originality, it is probably to their innate conservatism that they owe their continued national existence. In spite of the partial industrialization of their country, due to its harbours, its water power and its mineral


A fisher lad at Motrico

and its slender waist and agile legs, disappears.

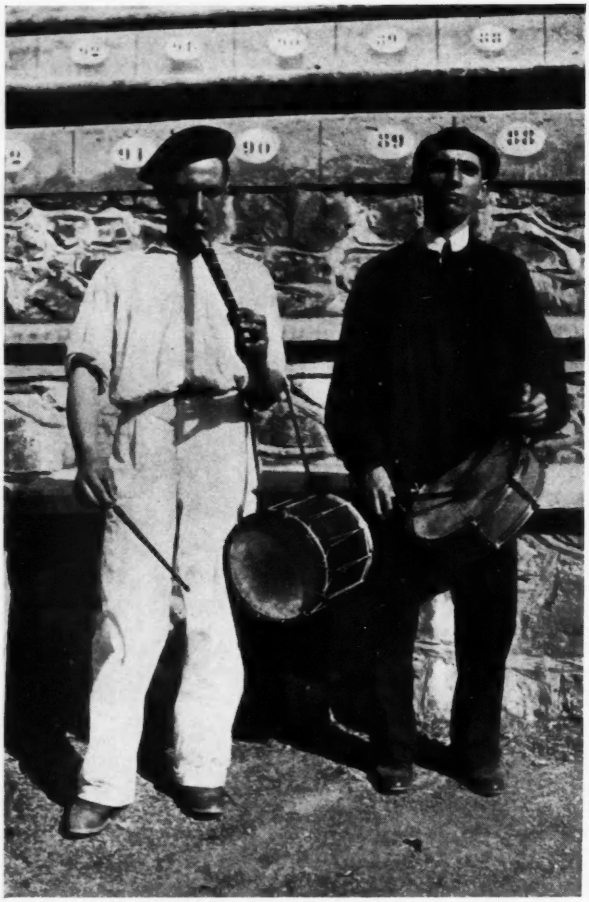
As Europe settled down at the close of the Middle Ages and conditions became more secure, the feudal strongholds of the Basque country were wholly or partly dismantled and transformed into smiling farms and peaceful manor-houses. At the same time the reputation of the Basques underwent a similar improvement, and in the seventeenth and eighteenth centuries they became known principally for their liveliness. De Lancre, who was certainly not prejudiced in their favour since he caused many of them to be burnt for witchcraft in 1610, describes them as "light and quick in body and spirit". There is also an oft-misquoted reference by Voltaire to "the people who dwell, or rather who jump, at the foot of the Pyrenees and who are called Vasques or Vascons". Lightness and agility are still to-day among their most pronounced characteristics and account for their remarkable skill at games and dances. Apart from the national game of pelote, derived originally from the *longue paume* of medieval courts, which has spread as far afield as Shanghai and Mexico City, they have produced a world champion in Pierre Etchebaster, son of a St Jean de Luz pastrycook, who is in a class by himself at real tennis, as well, of course, as the better-known lawn tennis player Jean Borotra. The sword dancers of Vizcaya can kick their feet to the ankle above the level of their heads, while the

deposits, they remain predominantly a race of peasants, composed largely of shepherds, farmers and fishermen. They are not numerous, at the most a million all told, and they do not occupy a large extent of territory. West of Bilbao, south of Pamplona, north of Bayonne and east of Mauléon, their language is no more heard, and the physical type, with its triangular face, its square, broad shoulders



A scene from the Pastorale of Francois I at Tardets

Funeral cloaks at Sare



Spanish Basque musicians

Mascarade dancers of Soule, with their hobby-horse, man-woman and sweeper as in our own Morris dances, can execute the *entrechat dix* and other *tours de force* of choreography achieved only by the brightest stars of the Russian ballet.

During the last hundred years, however, the Basques have acquired a well-merited reputation for more solid virtues than those of quickness and agility. Edward Bell Stephens, who came to know them well during the First Carlist War, described them in 1837 as "a highly intelligent, sociable and amiable people. They possess all the natural active politeness of the Irish peasantry without any alloy or servility, the sagacity of the Scotch without a symptom of its degeneracy into cuteness, and the steady self-respect which characterizes the upper classes of England, quite free from the leaven of Saxon stupidity."

Without necessarily associating myself with Stephens's reflexions on the inhabitants of the British Isles, I can fully endorse from personal experience his estimate of the Basques. In my *Book of the Basques* I attempted, in 1930, to condense my own impressions of them in the following words: "Loyalty and rectitude; dignity and reserve; independence and a strong sense of race and racial superiority; a serious outlook tempered by a marked sense of humour and capacity for enjoyment; deep religious feeling; and a cult of tradition amounting almost to ancestor-worship: all these correlated by a deep-rooted simplicity and a courageous, objective view of life." The abiding impression which they leave, above all things, is one of a robust, patriarchal people, splendidly healthy in mind and body. It might have been expected that so small a race, which has preserved its purity relatively uncontaminated for hundreds and even thousands of years, would inevitably show signs of exhaustion and degeneracy. Nothing could be further from the truth. One has only to look at the flourishing colonies of Basque emigrants

all over North and South America to realize that their vigour and power of expansion are undiminished. What influences have isolated their antiquated traditions and yet constantly rejuvenated the race? No purely geographical explanation will suffice. The solution must be found in some element in Basque character, some secret alloy of pride and dignity, of restraint and reserve, of conservatism and self-sufficiency which has given the oldest people in Europe the secret of eternal youth.

Pottery and Statuettes from Ancient Egypt

By E. N. Fallaize

(Since the application ten years ago of regulations governing archaeological research in Egypt, excavation has been carried on by native Egyptian archaeologists. Results of considerable value and interest have been obtained, as, for example, at Saqqara. The following notes record some of the more striking discoveries made in the course of excavations carried out in the early spring of this year.)

ONE of the most illuminating results of archaeological investigations in Egypt in the post-war period has been the discovery on a number of sites of traces of the cultural development of early man long before the dynastic period of Egyptian history begins—an event usually placed in one or other of the later centuries of the fourth millennium B.C. Leaving out of account the cultures of the Old Stone Age and the Mesolithic period, the earliest civilizations of the pre-dynastic ages may lay claim to neolithic status on the ground of the presence of pottery—not invariably crude, and indeed on certain sites in form, technique and decorative finish, attaining a high standard of excellence. Primitive methods of agriculture and the domestication of animals were practised in combination with hunting and fishing. Evidences of progressive development in civilization can be discerned; and the various stages of this development are distinguished according to the name of the site on which they appear—Badarian, Tasian or Gerzean civilizations and the like.

A site which in itself affords an instructive example of a continuous development in culture, extending over a considerable period of time, is Merimda-Beni Salama, situated to the west of the Nile delta. This site was occupied by a population of primitive agriculturists, who also engaged in stockbreeding and hunting. Although the Egyptian Academy of Sciences had carried on excavations on this site for six years, it was not until this last season, the seventh, that it was established that the Merimda civilization, as it has been called, had developed progressively throughout the period of occupation. The population, indeed, had remained unchanged; at all times their weapons and tools were similar, and their burial customs identical. Nevertheless it has now been possible by the aid of stratigraphical evidence to distinguish three well-marked stages of development.

Head of a woman in stuccoed and painted wood. The ear-rings are clearly seen

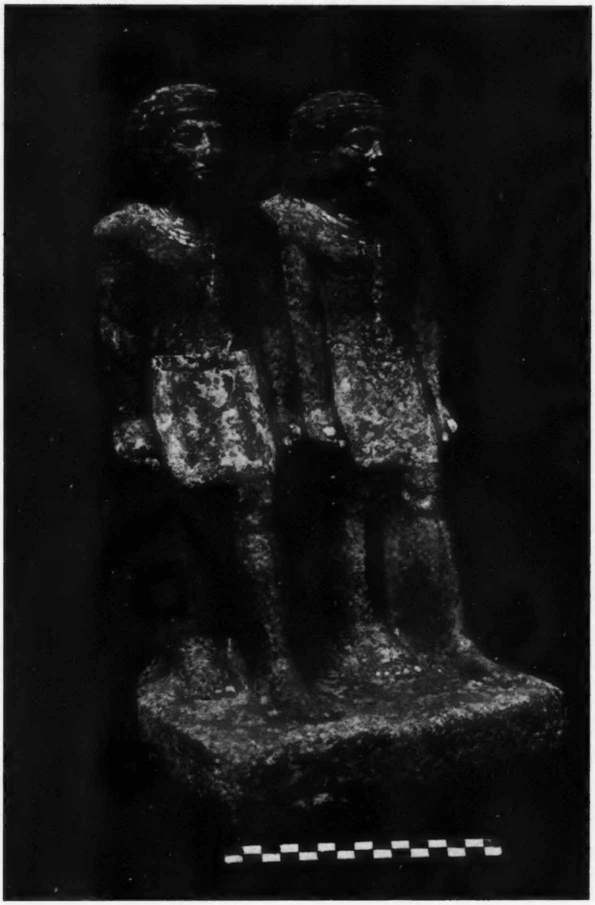
Side view of the head. This dates apparently from the New Kingdom

Three levels of occupation can be discerned. Of these the earliest is a wide stretch of sand, yellowish in colour, on which it can be seen that the inhabitants had lived in lightly constructed and widely spaced huts. The hearths appear as black deposits, and the interments are shown by greyish tints in the soil. The second level is of a light grey colour. Here the habitations were of a more substantial character, and closer together. In the third layer, which is of a deep blackish colour, consisting mainly of the debris of occupation, the proportion of sand is less than in the earlier levels; the dwellings were in a much closer agglomeration. They were oval in shape and constructed of lumps of clay. This form and method of construction makes its appearance for the first time in this third level, together with large baskets for cereals. These were buried in the earth; later their place was taken by large pottery jars.

Thus the evidence shows a continuous development from a scattered settlement to a compact village traversed by streets. Like evidence is to be seen in the pottery styles. While some types persist from the primitive settlement throughout the occupation, others disappear in the course of time. One form with a palm-leaf motif in decoration is found in the first layer, deteriorates in the second, and disappears entirely, and with it the decorative motif, in the third.

The important excavations of the Antiquities Department at Saqqara, where the Step Pyramid and adjacent structures have

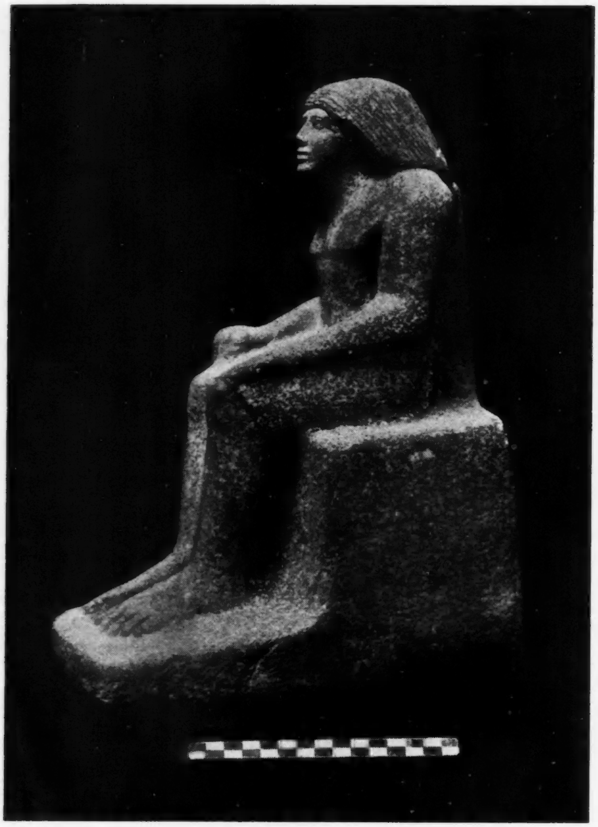
been under examination for some years, have been intermitted in the last two or three seasons in order that the work of clearance and conservation might be pushed forward. Nevertheless some interesting finds came to light this year, among them three little granite statuettes which had been stolen by robbers and then abandoned. They belong to the Fifth Dynasty. Two of them represent the same person standing. They bear traces of colour on the head, the eyebrows, the eyes and the nails, while the granite represents the skin. The clothing was also painted. The third statuette of black granite also shows evidence of colour, and is inscribed with the name and title of Her-en-Kaw, Director of the Scribes of the Textile Fabrics. A head of a woman in stuccoed and painted wood, dating apparently from the New Kingdom, shows a pair of earrings painted black.



Two granite statuettes 43 *cm. high. They were found at the foot of the pyramid, having been abandoned by robbers*

Evidence which may prove of considerable historical interest, though its exact bearing has yet to be made manifest, was brought to light in clearing the south side of the Pyramid of Unas. In order to build his pyramid, Unas evidently destroyed the funerary monument of his predecessor Dadkare. This action, in conjunction with certain inscriptional material which was found, raises the important historical point as to the identity of the ruler responsible for the change of dynasty usually attributed to Teti. This question still remains *sub judice.*

At Hermopolis West (Tuna el Gebal) excavations of the Fouad I University, which in the previous season had been occupied with remains of the Ptolemaic period, were now pushed forward to a stage at which, by the end of the 1939 season, material belonging to the age of Psammetichus and Amasis in the seventh century B.C. was being examined. The galleries in which these investigations are being carried out, it was thought previously,



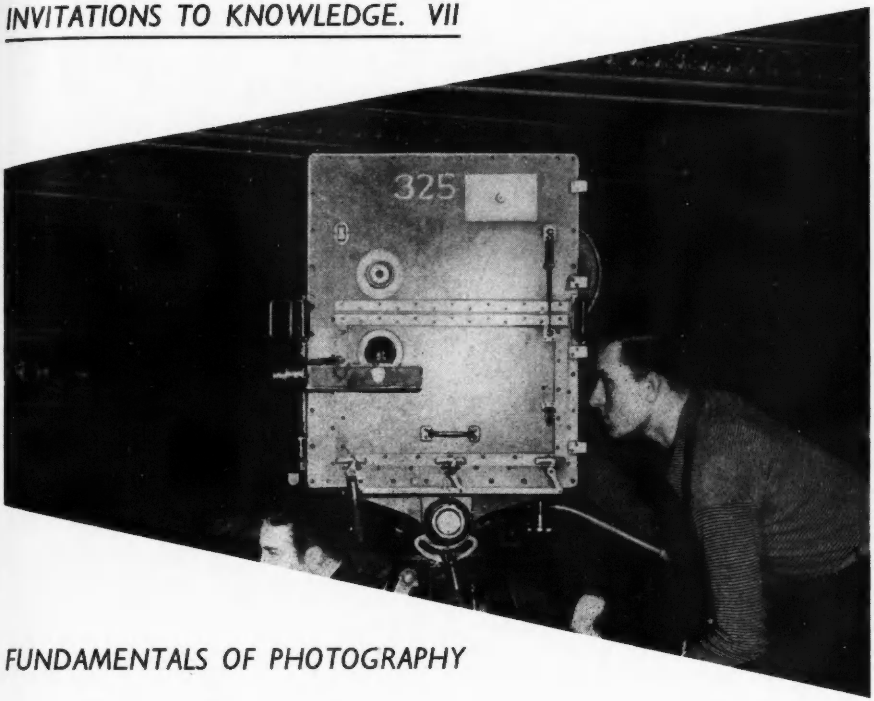
The third statuette of black granite inscribed with the name and title of Her-en-kaw

had been reserved for the mummies of ibises and baboons; but in a room cut below the gallery was found a sarcophagus, which proved to be that of a chief priest and prince of Hermopolis. The chamber was filled with canopic jars of alabaster, which were covered with inscriptions. These jars stood in pairs on each side of the sarcophagus. Their covers were carefully sculptured with the heads of the "Four Sons of Horus". At the right of the sarcophagus at the foot were four hundred of the little votive statuettes, known as *ushabti*, in blue faience, and inscribed with the name of the high priest, Ankh-hor. On the east side were several blue faience vases containing unguents, fruits and gilded leaves. The sarcophagus contained a mummiform coffin of wood; and the mummy wore a mask of silver, while a band of gilt leather lay on its chest. On both sides of the body were two sheets of gilt bronze bearing in relief figures of the "Four Sons of Horus".

In another corridor jars, which had not been disturbed by robbers, yielded one hundred and twenty-five statuettes of Osiris in bronze, statuettes of Isis and of the sacred bull, and a composite piece in which a prince of Hermopolis stands between the goddesses Isis and Nephthys, with Horus in front of him, standing on a lotus column, flanked by the two uraei of Upper and Lower Egypt. This piece stood before an ibis seated on a stand, sculptured and set with stones which imitate lotus flowers.

A German expedition to Hermopolis, excavating on the Tell-el-Ashmunain, in clearing the ruins of a pylon of Rameses II found that the foundations of the pylon were constructed of blocks from a destroyed temple of Amenophis IV (Akhnaton), many of which are decorated with reliefs in the well-known Amarna style. Although not yet completely reconstructed and studied, it is already evident that the scenes depicted show the royal family and phases of court life.

INVITATIONS TO KNOWLEDGE. VII



FUNDAMENTALS OF PHOTOGRAPHY

THE fundamentals of photography, which is now nearly everybody's occasional occupation, are no more than two physical facts: that light travels in straight lines, and that light can change certain materials so that the change remains after the light is withdrawn. Because of the first of these facts, light from a point casts shadows of objects which are the same shape as the objects; because of the second when pictures are taken down from a wall during spring cleaning the places of the pictures are apparent by the fading of the wall paper all round them. The very first experiments of printed photography were simply shadows made permanent. One of the substances changed irretrievably by the action of light is a salt of silver. If a piece of white paper is soaked in a dish of water in which a little salt has been dissolved, and then, when it has dried, floated for a minute on some water in which silver nitrate has been dissolved, the silver in the solution combines with part of the salt that had dried in the fibres of the paper to form a white powder, called silver chloride, which is sensitive to light. Let the floated paper hang up in the dark to dry, and then gather one or two leaves of intricate shape, and lay them flat, under a sheet of glass, upon the prepared and dried paper. They should be in a place where sunlight or strong daylight falls.

While you watch, the colour of the paper will change from white to violet simply by the action of the light, and when you take away the glass and the leaves the shadow shapes of the leaves will remain in white upon this darkened ground. Light has done no more than flood up to the edges of the leaves, giving up some of the energy of which it consists to change white silver chloride into a darker form. Where the leaves kept away the light the silver

chloride did not change. But now, when the leaves are taken away, the light floods the whole sheet and you may watch the white shadows darken, just as the rest of the paper darkened, till all is one even colour and the leaf shapes have vanished.

The experiment is so pretty and satisfying while it lasts that you are bound to wish the effect might be more permanent; that, at least, is what the earliest experimenters wished, and they tried all kinds of treatments of the sun-imprinted paper until at last they found a way of removing all the undarkened silver chloride and leaving only that which had been changed by the light.

With this elementary method of photography nothing but flat shapes could be recorded. But there had been in existence for many years a fascinating toy able to give in the colours of nature a detailed image of any scene or object placed before it. Anyone can make a rough model of such a thing for himself. Nothing is needed beyond a box and a piece of thin white waxed paper. In place of the lid of the box the waxed paper is stretched, and in the middle of the bottom of the box a very small sharp-edged round hole is pierced. Now, if the hole is pointed towards a lighted candle, an image of the candle will be seen, upside down, on the waxed paper. The image is formed, and formed upside down, because light travels in straight lines. You will see in a minute from the accompanying diagrams 1 and 2 why a pin-hole produces such an image. In diagram 1, the candle is shown as giving out rays of light in all directions. The rays for one point of the flame only are indicated in the drawing. Many rays fall upon the opaque sides of the box and cannot get through. These are absorbed or reflected. But those that fall upon the pinhole go straight on and are stopped by the waxed paper, which they faintly illuminate at a spot (*a*) which is in a straight line with that between flame and pinhole. The foot of the candle *B*, though not itself a source of light, is of course lit up by the flame light either directly or by reflection from the walls of the room. Light falling upon it from many directions is scattered by it in all directions (this you may be sure of because you can see it from all sides). In diagram 1 only that one ray is drawn which happens to go in the direction of the pinhole. It will not be a bright ray, but it will be brighter than the unilluminated waxed paper, and will therefore dimly light the spot marked (*b*). With reference to *A* and *B*, *a* and *b* are upside down. We have only marked two points where rays from the candle and its flame pass uninterrupted through the pinhole to the screen, but many rays from all parts of the candle will pass through in the same way and fall upon the screen in their proper place, all together forming an image in light, with all visible parts of the candle projected upon the screen in their proper place on the inverted image. If you make other diagrams varying the distances between screen and pinhole (*SL*) or between pinhole and candle (*LO*) you will discover at once that the size of the image changes according to the relation of these two distances. When they are equal the image is the same size as the object, when *SL* is greater than *LO* (the candle nearer to the pinhole than the screen is) the image will be larger than the object, and when *SL* is less than *LO* (as in diagram 1) the image is smaller in proportion.

In theory now at any rate you have the materials for taking a photograph: you know how to produce an image in light, and you know how to make that image record itself, by the action of light upon silver chloride. But if you made such a pinhole camera and substituted for the waxed screen a sheet of the salted and silvered paper, your patience would be exhausted long before the weak light admitted through the pinhole had any effect upon the paper. In bright sunlight for many hours you might get marking enough to prove that the thing was not impossible, but little other encouragement. Either you need more light, or a more sensitive recording surface, or both; and along these

lines, of course, the earlier experimenters worked.

If the need for more light suggests enlarging the hole, do not spoil your primitive camera before you have examined diagram 2, where what happens with a larger hole is clearly discoverable. Now, not a "ray" but a number of the rays diverging from A and B (and all other points) will find their way to the screen. The single point A will illuminate the screen from a' to a, the single point B will illuminate the screen from b' to b. Not only will neither of these points be represented by a point in the image, they will actually overlap and confuse each other and no one will know of the area a' to b whether it is the top or bottom of the candle. In fact, your photograph, if you got more light by making a larger hole, would be an unrecognizable blur. The pinhole puts the photographer in a dilemma—the smaller the hole the clearer the picture but the less the intensity of light. It is not impossible to take a photograph with a pinhole camera if one uses some of the most highly sensitive modern plates or films, but even the best of pinholes admits more rays than are wanted for sharp edges, and at the same time less light than is wanted to record anything in a suitably short time. A moderately clear snapshot would be out of the question.

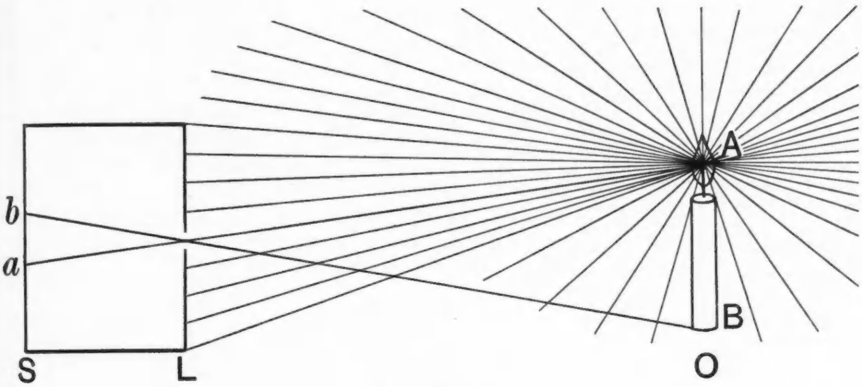


Diagram 1

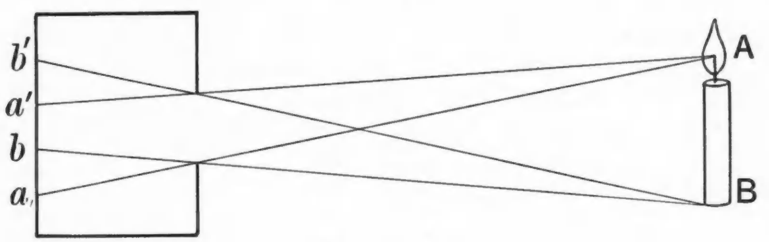


Diagram 2

Much more light, without loss of definition is obtained by the use of a lens, which in its fundamental form is a solid piece

of transparent matter (generally glass) whose *thickness* varies according to the laws of spheres. Diagram 3 shows in its shaded parts the shapes of two kinds of lenses in section—the double convex (or outward curving) and the plano-convex (i.e. with one side not curved). It is clear that any double convex lens could be described

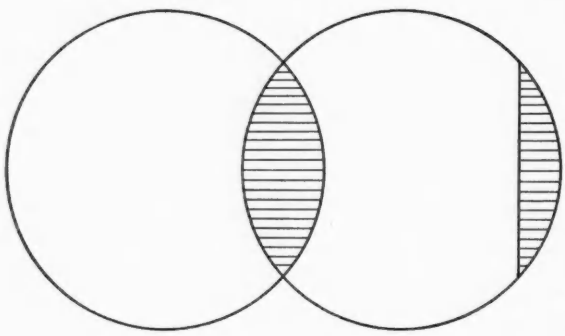


Diagram 3

as two plano-convex lenses placed plane-face to face. You will notice that it is an essential quality of a lens that it is part of a sphere, that is that it is built up of transparent material strictly about a geometrical centre or point.

which fall upon the lens are now deflected by the lens according to its curvature towards a single point or *focus* on the screen; and all the light, which, without the lens, was scattered over the screen from a' to a in Diagram 2, is now falling upon a single point. The same is true of course of rays from any other part of the candle. By means of a lens we have got the advantage of a larger pinhole (more light) without the disadvantage (loss of definition), and the picture of the candle is a great deal brighter. There is, however, one important difference between the superficially similar images produced by pinhole and lens. Take away the screen in Diagrams 1 and 4. In Diagram 1 points a and b are simply the points where the single rays met the screen, and if you take the screen away points a and b disappear. In Diagram 4, however, a is a point not depending on the screen but on the meeting place of a number of rays from A, and if you take the screen away the image remains there. It is a real image, and can be seen in space in its proper position even

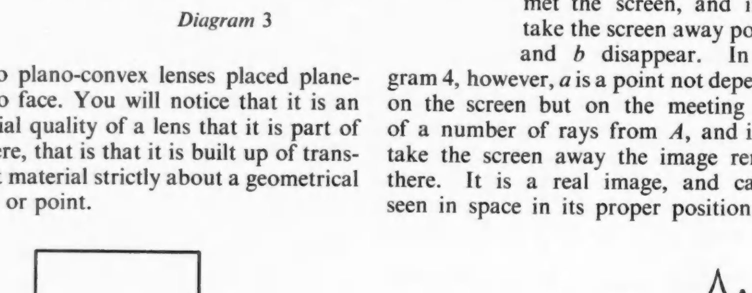


Diagram 4

Let us re-draw the second diagram now as Diagram 4, putting a lens into the large hole which, we found, destroyed the definition or clearness of the image. Of the rays going out from the point A in the flame all those

without a screen. You can see the world upside down in any magnifying glass held at arm's length. The screen in Diagram 1 will record its a and b at any distance behind L. That in Diagram 4 must be at the

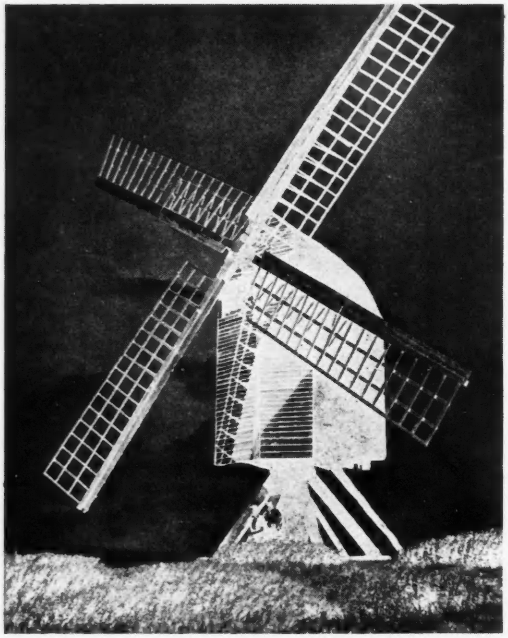
point of intersection of the rays themselves. Thus lens cameras need to be *focussed*, but pinhole cameras need not; and you will find that most efficient cameras either have a measure (marked in distances from the subject) by which the distance between *L* and *S* is correctly adjusted, or else some means by which, before the photograph is taken, the photographer can look at the image and see that it is clear and sharp. With a box camera of fixed focus there is only one correct distance between lens and subject (generally about 15 ft.) and anything nearer or further will not be perfectly sharp and clear.

It is a matter for the science of optics to explain why a slice of a sphere of glass produces an image, and here what can be said must be brief and general. Light travels at a speed that varies with the density of the transparent substance through which it travels. When a ray of light passes from air into denser glass its speed changes. If the surface where glass and air touch is obliquely and not directly across the path of the ray as in a lens, the direction of the ray changes. Since a simple lens is throughout its substance constant in the material it is made of and constant in the geometry it is made by, all the rays it receives are deflected according to a single law (based on its form and density) and the system of the emerging rays bears an exact relation to the system from which the arriving rays were collected by the lens. The image is made from the object and is like it because the lens is a unity. The perfection of the lens has been the constant aim of workers on the optical side of photography, and though some of the lenses now made seem as good as they can be, progress in special directions continues.

It will be clear from Diagram 4 that in a general way the larger the diameter of the lens the more light will be admitted, but that the *intensity* of the light at the screen will depend upon the distance between lens and screen. It is, of course, intensity at the screen and not mere all-over quantity of light that is important, and camera makers have therefore devised a way of describing the size of the lens-opening (or aperture) in terms of the focal-length (or the distance *SL* when *LO* is more than 100 ft.). Most cameras have a means of varying the size of the aperture, and the scale by which these sizes are graduated is really a scale of intensity. An aperture of *f*/8 means an opening of diameter one-eighth of the focal length of the lens—thus *f*/8 for an 8 in. lens is an opening of diameter 1 in., and for a 4 in. lens is $\frac{1}{2}$ in., but the intensity of the images cast by these two lenses at an aperture of *f*/8 will be the same. The scale is generally marked at points so that each aperture admits one-half the light admitted by the mark preceding it—i.e. *f*/11 admits only half as much light as *f*/8, *f*/16 only half as much light as *f*/11. This is done for convenience in deciding how long an exposure to give—the simple rule is to double the exposure for every standard reduction of the opening.

Some one may well ask at this point why we should need mechanism to reduce the opening after having gone to such trouble to increase the opening by which light is admitted. To have a variable aperture is useful for two reasons. First, conditions of light vary enormously, and a large opening which would give a satisfactory picture at $\frac{1}{25}$th sec. on a dull day would admit far too much light at the same speed on a sunny day. It is often easier to reduce the opening than to alter the length of exposure. Second, the smaller the opening the greater the average clearness of images of objects at different distances. The rule of thumb to get the best result from a lens is, therefore, to employ the smallest aperture that light, speed of film, and shutter, will allow.

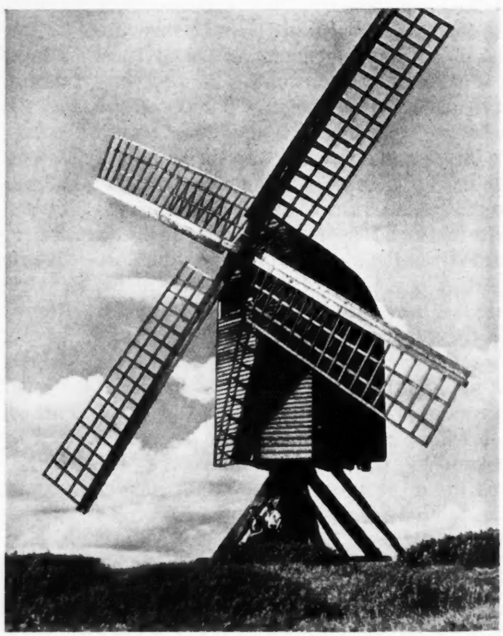
The other important end of the camera is the film or plate upon which the image records itself. From the salted paper which was in fact the first attempt to make light itself manufacture a permanent record of itself, chemical research has gone steadily on, until at the present time it is possible to take a photograph in almost any visible



THE NEGATIVE. The finished product of the camera, with shapes and tones of metallic silver directly corresponding to the shapes and tones of light in the subject.

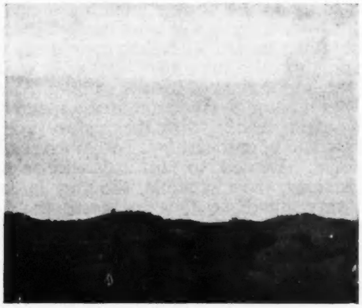
light and, indeed, in "lights" such as ultra-violet and infra-red (see p. 549) which leave the human eye in darkness. The basis of nearly all light-sensitive substances in use in camera photography is still compounds of silver with the group of elements including chlorine, iodine, and bromine. The advances in sensitivity have been due to increasing technical knowledge—often not fully explained even now—of the exact conditions under which the emulsions are made and matured.

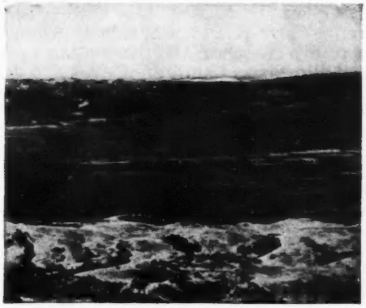
A film or plate, apart from the transparent celluloid or glass support, consists of a thin skin of gelatine in which are suspended minute particles of silver chloride or bromide. These particles have been formed in their place in darkness, and the first glimpse of light that they receive comes in the shape of an image of the outside world cast upon them by a camera lens. The shock of light (even only a glimpse of it for a thousandth of a second) changes these particles in nature once and for all, although by inspection no one could tell whether or not a film had been exposed to light. There is no change of colour, as there was with the salted paper. But chemical treatment, called development, can make a distinction between those particles that have been shocked by light and those that have not.



THE POSITIVE. A product of the negative, a simple inversion of its lights and darks. In the positive there is least dark silver where in the subject there most light.

The film is soaked in a developer whose action is to change into black metallic silver grains all those silver halide particles that have seen the light—the more the light the more the dark change—and what results is the opposite, in light and dark, of the original scene—black skies, black faces, white clothes, white shadows. This is called the negative, as everybody knows. Since the final result of the action of light and developer is a simple interchange of brightness and darkness, the negative can be used to produce a true picture by being itself copied in its own process. White of original scene becomes black of negative, and by using the negative as the mother of prints, black of negative becomes white of print—therefore white of original becomes white of print. The negative, however, is the true culmination of the process of photography. It is worth remembering that a negative is as much an untouched natural phenomenon as a crystal. Man, with his knowledge of two of the qualities of light (its straight-line travelling and its power to modify silver compounds) has arranged the stage, no more. The best photographer never forgets that he is present mainly as witness at a natural phenomenon, and that if he gives a free field to the laws of light, rays cast by the sun, scattered by the windmill, and admitted by the lens, change by their energy the silver that awaits them and leave, in silver, a pattern of tones. The *picture* of the windmill is made by our minds.





PHOTOGRAPHS TAKEN IN "LIGHTS" THAT THE EYE CANNOT SEE. *On the left a photograph taken through a filter which excludes all but the ultra-violet light, on the right a photograph taken, at the same time of the same landscape, through a filter which excludes all but the infra-red light. Atmospheric haze reflects and scatters ultra-violet light but is more transparent to infra-red than to the visible light of the spectrum. Photographs making use only of infra-red light show distant detail that cannot be seen by the eye.*

FRANK KENDON

Reviews

Anthologia Anthropologica

The name of Sir James Frazer is written indelibly in the history of anthropology in the Australian Realm, not only on account of his own painstaking researches in Australian totemism, but also for the inspiration that, both as a man and a scholar, he gave to the now classical work of Sir Baldwin Spencer and F. J. Gillen. To all who have read *Spencer's Scientific Correspondence* the extent and importance of this influence, and the greatness of the Grand Old Man of anthropology, stand out.

Leaves from the notebooks of Sir James Frazer must prove a valuable addition to the literature, particularly those referring to the Australian field, and the editor is to be congratulated upon the careful presentation and documentation of the notes contained in this volume.* In common with *Totemica*, published recently as a supplement to *Totemism and Exogamy*, there is no theoretical discussion nor any attempt at the compilation of a full bibliography, but the aim of the author and of the editor is to present in documented form, duly indexed, the material gleaned by the scholar through the years, and not previously published in earlier volumes.

No complete tribal map of Australia exists, but the editor is perhaps a little unfortunate in his selection of representative tribes in Northern Australia. Thus, the names of certain tribes which appear on the map opposite p. 16, for example the Worora, Tiwi and Yiryiront, have but recently been added to the literature, and are not mentioned in the text, while others, which are discussed, such as the so-called "Yaraibanna" of Cape York (p. 43), are omitted from the map.

The field covered by these miscellaneous notes ranges over an area as far flung as the Maldive Islands, the Andamans and Nicobars, and New Zealand. The volume contains much valuable information and many records not easily accessible to the student, and as such will find a place in every anthropological library.

D. F. T.

* *The Native Races of Australasia*, by Sir James Frazer, arranged and edited from the MSS. by Robert Angus Downie. Percy Lund Humphries, 35*s*.

Putting Across the Insects

Dr Burr, who needs no introduction to readers of *Discovery*, is an entomologist with wide field experience in many parts of the world from Angola to Siberia, and a store of knowledge which makes him an authority on more than one order of insects and a reliable guide to the remainder. In *The Insect Legion** he has compiled, from his own experience and from the writings of his colleagues, a very varied collection of entomological facts and anecdotes, and by drawing more freely on foreign species for his illustrations than most popular writers he has made the book something more than an up-to-date version of what has been done so many times before. There are several chapters, besides those dealing with habits and behaviour, on the importance of insects to man, particularly in relation to crops and disease, and there are others dealing with the history both of insects and of entomology. Too much space is, perhaps, devoted to an insistence on the marvellous, the incredible, the very large, or the very small, so that in places the book degenerates to the level of a "Believe it or not" feature.

We cannot help thinking that this attitude does an injustice to the public to which the book is directed. Dr Burr, as his articles have often shown, knows how to interest the public in the real principles and problems of entomology; it is all the more to be regretted that parts of this book are matter less for intelligent interest than for idle curiosity.

D. A. W.

* *The Insect Legion*, by Malcolm Burr. Nisbet, 12*s*. 6*d*.

The Position of Plant Morphology

Morphology is more than the investigation of form; it is the whole set of ideas behind it. The morphologist's object is usually to work out a comprehensive scheme which shall apply to a multitude of very diverse plants. Long ago such a scheme was worked out for flowering plants, their parts being analysed by a simple set of rules into the categories of root, stem and leaf. For all but a few plants the scheme works smoothly until we come to the flower; its value is that it enables people to talk about one plant after another without risk of being misunderstood.

The flower, though analysed into axis and floral leaves, has never proved easy, and while great progress has been made in elucidating facts about flowers, the theory is chaotic. At least four widely different views are being put forward by English-speaking botanists alone. One of these, "the classical theory", is held by some who have studied the flower, and in a

vague way by nearly all who have not. The other three began as onslaughts from different angles on the classical theory, they are as yet held by few besides their protagonists. Miss Saunders' theory was the first; it has been worked out in a great many papers and in the present two volumes* she has applied it to what must be every available family. She is concerned chiefly with the gynaecium, analysing it into theoretical units called carpels which are different from the classical carpels. Thus many capsular ovaries are analysed into twice the classical number, one set of outer sterile ones forming the ovary walls, an inner set of alternating fertile ones forming the placentae and partitions. One or both sets may form the stigma, thus providing a neat explanation for some of the variation in stigma shape. She recognizes a number of different types of carpel, two of which usually contribute to form a particular ovary.

It might seem that a section through an ovary would at once show whether Miss Saunders' or the classical theory was right. Miss Saunders would say it did! But her opponents remain unconvinced. The difficulty is that the carpel is not so much a real thing as an idea (a bad idea according to Prof. McLean Thompson) or if partly real, then still partly ideal.

A great deal of the difficulty arises through the widespread phenomenon called fusion of parts, which can be illustrated more simply for the petals than for the ovary. The buttercup flower, for example, has all its parts separately joined to the receptacle, while in the primrose the petals are said to be fused below into a tube, to which also the stamens are fused. In the very young bud of the buttercup little lumps arise on the sides of the dome-shaped receptacle, and these lumps grow into the petals and stamens; the very young primrose bud is at first similar having lumps which give rise to the free parts of petals and stamens, but below these a ring of tissue grows carrying up the whole set of young petals and stamens. This part is a continuous tube, at no stage had it separate pieces which later merged into one. Speculative morphologists discuss just such matters as the nature of this tube, and although nearly all agree that it is composed of petals and stamens they do so in different ways. Certain philosophical morphologists have insisted that these units are merely ideas (of petals and stamens); their position seems only assailable by a rival set of ideas aesthetically better. British morphologists, however, have seldom any use for intellectual Botany; they only value tangible units and they look for them, if not on the surface, then inside. The soft tissues are perfectly continuous, so that no boundaries can be distinguished, but the vascular strands (veins) are definite things which can be allotted to morphological units. They prove to be fairly simply related to the veins of the free parts, so this analysis proceeds nicely, sometimes with most interesting results as in certain flowers where veins related to vestigial stamens have been recognized.

Miss Saunders makes great use of these veins in her analysis of the ovary, distinguishing a carpel unit where she finds a particular group of veins; she uses also the form of ovary and stigma but the anatomy comes first. Early development she finds unhelpful and does not use at all.

The reviewer is not competent to judge of right and wrong between Miss Saunders and the classic theory. He can only say that her view is definitely the easier to him for some families (especially the crucifers); about equal for very many; definitely harder to grasp for things like *Delphinium* follicles which she describes as $\frac{1}{2}+1+\frac{1}{2}$ carpels, the halves belonging to an inner fertile set which have "fused" with the alternating outer sterile ones. However, for data on this subject, one must go to her papers; her book is almost entirely concerned with applications.

These remarks would be incomplete without some mention of morphological controversy. Miss Saunders' work is a challenge, it has occasionally met active opposition, but rather seldom has any real contact been made. The difficulty is that flowering plant ovaries have been approached from the standpoint of ideal morphological units; or of vascular anatomy, or of early bud development or of possible evolution and each approach has led to different sets of ideas, which are only applicable in the one particular approach. The resulting discussion is scarcely of a nature to lead to conclusions and I would be tempted to join the critics who say the whole thing is unreal if it were not that I, like nearly all who have studied plant form, am at times convinced that there is something real behind it, though at times, too, I wonder whatever that something can be.

T. M. H.

* *Floral Morphology, a new outlook, with special reference to the interpretation of the gynaecium*, by E. R. Saunders. Vol. I, 132 pp., 3*s.* 6*d.*; vol. II, vii + 609 pp., 10*s.* 6*d.* W. Heffer and Sons, Cambridge.

Earth's Green Mantle

The number of elementary text-books on botany, designed for this or that class of examination candidate, is countless. The number of books designed to draw the attention of the general reader to the subject of botany and to arouse interest in it, is zero, or was, until Professor Mangham wrote *Earth's*

Green Mantle; and his book * is a courageous attempt at a difficult task.

It begins with a rambling chapter about kinds of plants and where they live, which makes a good introduction. The second chapter, on geology and fossil plants, is too long and technical, and is out of place. Fossils and their meaning in evolution are, to the general reader, more interesting from the zoological side. The next chapter, on Plants and Man, describes how plants, spices, for example, were important in influencing early trade, and how improved technique in systematic botany has influenced economic botany. Like the next two chapters, which deal with the origin and development of plant physiology and morphology, it is mainly historical.

This discursive series of chapters, designed to rouse the reader's interest, would be improved by the omission of Chapter II. Eventually, in Chapter VI, we come to grips with the plant itself; the structure and mechanisms of the flowering plant are described in some detail, emphasis being laid on the structure of the cell, and the complexities of its metabolism. There is a chapter on reproduction and heredity, and a clear account is given of elementary Mendelism. A good short chapter on diseases caused by plants leads to the final chapter, which summarizes some of the more interesting applications of botany, as, for example, in the fight against soil erosion.

Although the first part of the book is fairly easy reading, much of the second part is difficult. Not only is there too much detail for the general reader, but there are too many technical terms, often insufficiently explained. In the reviewer's opinion the long historical introduction, though it has its advantages, is a mistake; it would have been better to begin with a simple account of the structure and function of the flowering plant, and to build on this. In this way, the treatment would have been more up-to-date, and the author could have developed some of the topics now relegated to the last chapter. Much more emphasis might have been laid, for example, on the part played by plants in the carbon and nitrogen cycles, and on the relation of these cycles to other subjects, such as agriculture and soil science.

The book is abundantly illustrated; the diagrams are good, but often too complicated. Many of the photographs are first-rate, but many redundant. A series of 10 plates containing 40 or 50 photographs shows miscellaneous vegetation in different parts of the Empire; half a dozen of these photographs would be enough. Pictures of familiar British plants and communities would interest the general reader more.

In spite of its many failings, *Earth's Green Mantle* is successful because the author has an enthusiasm for botany which infects everything he writes. The reader feels that Professor Mangham is wholehearted in his desire to *know* about plants and to pass his knowledge on; and botanists will be grateful for the book, which is a service to their science.

D. H. V.

* *Earth's Green Mantle. Plant Science for the General Reader*, by Sydney Mangham, M.A., with a foreword by Sir A. W. Hill. The English Universities Press, Ltd., London, 10*s*. 6*d*.

Arctic and Antarctic: The Technique of Polar Travel

COLIN BERTRAM'S book* is one which most polar travellers would like to have written themselves. To compare one's own resources with those of others, to hold that one's own pemmican is undoubtedly the best, and to stick up for one's own gear generally—these are common features of all expeditions. Many, if not all, who come back from the Arctic or Antarctic have wished that they had

had the time and the opportunity to write such a book as this, and compare their own technique with that of the past. Bertram,

* *Arctic and Antarctic: The Technique of Polar Travel*, by Colin Bertram. 7*s*. 6*d*. net. W. Heffer and Sons, Cambridge.

however, is the first actually to make the attempt, and it is one which will be commended by all polar travellers. He is a biologist and alive to the idea of continuing evolution and that no detail of equipment can ever be the last word. He finds himself strongly supporting McClintock for instance, who deprecated the almost entire lack of progress in the outfitting of the Nares expedition in 1875. Bertram is aware that he himself is recording a stage only in polar technique, not a final condition, and that any future expedition without fresh ideas in its methods will have little to recommend it.

The various chapters deal with food, clothing, tents, transport, and so on; and some have titles such as "Why?", "Memories", "Cold". Each contains a sketch of the present-day customs in the particular matter under discussion, illustrated generally with paired photographs, one of the old method and in contrast something new. The comparisons are done lightly and with full justice to the past. In more recent times Shackleton did much to improve equipment, and since the War Watkins has had much the same elastic methods. After Amundsen's and Scott's polar journeys dogs were recognized as the best form of transport for long journeys. Rations also had been put on a proper basis for Shackleton by Colonel Beveridge, who did for polar pemmican in 1914 what has perhaps still to be done for Everest rations. The changes in the twenty-five years' interval are for the most part changes in tent routine and in details of personal clothing. Rations alter with each expedition, with the season, with the output of energy required, and much also with the individual. These and similar points are brought out in turn, but without undue historical documentation. The book gives a picture of Antarctic travel in our time, which other travellers will approve and welcome. Personally I appreciate as much as anything the writer's biological background, and not least his dedication: To heredity and environment, my parents and my friends.

J. M. WORDIE.

Ten Years Under the Earth

THIS is one of the few books published in England on the subject of speleology,* a subject which, perhaps, is too little known to the public. Norbert Casteret, the author, one of France's most famous archaeologists and cave explorers, relates in his delightfully flowing style some of the episodes which he has experienced during his ten years of subterranean exploration.

Prehistory, a knowledge of which is essential to the speleologist, is a fascinating study; and the first three parts of the book deal with this subject from the point of view of the cave explorer. But it must be remembered that not every cave has the skeletons of cave-bears hidden in its sticky red clay, or prehistoric drawings on its walls. The author has isolated examples from his various discoveries in order to show what one must be prepared to find underground. His descriptions of some of the animals which roamed Europe in Pleistocene times, and the little sidelights on their condition and habits, which M. Casteret has been able to glean from their bones and from numerous marks in the caves, is particularly worthy of note.

Another part of the book deals with some of his major discoveries and adventures under the Pyrenees, his native district. Anyone who is acquainted with cave exploration can understand his astonishment at finding a quantity of cave-pearls in the cavern of Cagire. In the heart of the Monte Perdido Massif he discovered, and actually skated in, the first ice cavern to be found in France. To-day it is known as the "Grotte Casteret".

The most thrilling chapter of all is the one in which he describes the "Gouffre Martel", named after the world-famous French speleologist, E. A. Martel. It was discovered by M. Casteret when carrying out some explorations of underground watercourses for a big hydro-electric scheme. The first time he came upon it he was dangled on the end of a rope, by two exhausted companions, over the brink of this chasm 1566 ft. deep; but little did he know of its depth then. Later he returned, and, by means of M. R. de Joly's light steel-wire ladders, descended into this deepest abyss in France. He does not describe the agony of ascending 1566 ft. of ladder, but it can well be imagined.

The rest of the book deals with numerous subterranean phenomena such as cave-pearls, helicite formations, and delusions which one may experience underground. It certainly is startling to learn that M. Casteret actually heard and felt the heart beats of his companion, who was a few yards behind him when they were negotiating a particularly tight crawl. Apparently the throb had been amplified by the hollow stalagmite floor, and sounded like the beat of a big drum.

Another chapter is devoted to modern cave fauna, and tells of animals which are born, live and die underground, and others which live there temporarily or accidentally. The last chapter relates how, by a dramatic coloration test, he once and for all located the true source of the river Garonne, and thus averted what might have proved a tricky international dispute.

This book will open up an imposing new

* *Ten Years Under the Earth*, by Norbert Casteret. Dent, 12*s*. 6*d*.

vista, of the subterranean world with its rivers, its extraordinary crystal formations, its lakes, its animals, and finally its fascinating mysteries. It tells of the only field open for exploration in Europe; and it shows what successes and discoveries await a man of ability, determination, and endurance, such as is M. Casteret himself. It is liberally illustrated with some fine photographs, some taken by the light of the sun, others by the vivid glare of a magnesium flare, far below the surface of the earth. *Ten Years Under the Earth* was honoured by the French Academy, and this edition of it, ably translated by Barrows Mussey, contains a few extra chapters from another of his books, *Au fond des Gouffres*. It cannot fail to capture popularity and should find its place on the bookshelf of every home.

R. O. NOONE.

The World of Insects

THIS is one more of those popular books on Natural History which our American friends produce so well.* The illustrations are profuse and well reproduced, at the price of the great weight of what is not a big book. It is a very useful introduction to the study of Insects on somewhat original lines, explaining how they are born, grow and live, their social life, their voices, protection, and how they move, and deals with an aspect that is seldom touched in popular works.

Classification is not overdone; and there is a tabulation of the orders, which makes the essential features stand out clearly. The Collembola, though mentioned earlier in the text, are omitted.

The concluding chapters deal with the good and evil done by insects and their control, and finally give practical advice for collecting and preserving specimens.

The language is clear and simple, and the numerous photographs are excellent. The most impressive is Fig. 162, showing a large hawk moth sipping from a thistle head.

The chief fault in the book is that fear of using scientific names, which is common to almost all popular books, with the result that an Englishman may well wonder what is meant by a Jerusalem Cricket or a Wingless Hanging Fly, both names and creatures unknown in our country.

But the fact that the book is addressed to the youth of North America, and so describes hosts of creatures that do not occur in our islands, is no handicap. On the contrary, a similar book dealing only with British insects would give but a fragmentary picture of Entomology. For this very reason this American book is more comprehensive and valuable.

M. B.

* *The World of Insects*, by Carl D. Duncan and Gayle Pickwell. (McGraw-Hill, New York and London, 21*s*.)

Geomorphology

ANY book by Professor Lobeck is worthy of attention because it is bound to be well illustrated but his new and comprehensive text-book on geography† marks a still further advance. The subtitle is perhaps more accurate than the main one, since the author does not attempt to go into minor details, nor to consider fully the theories in which this subject is so prolific. He sets out to present the subject in such a way that even beginners can follow the whole book, using the deductive method of presentation.

In addition, he has taken great trouble in finding illustrations and diagrams to suit the text, and in almost all cases the illustration is opposite to the text to which it is relevant. This large and truly magnificent selection of photographs almost puts the book in a class by itself.

Though dealing in the main with examples from the United States, and especially the Middle West, where land forms are so naked and so plain to view, the author makes constant excursions to other parts of the world, particularly for English examples.

It will be gathered therefore that the book is mainly descriptive; but with such a wealth of illustrations and examples it is, in the opinion of the reviewer, bound to become one of the classics of this somewhat new branch of study.

F. D.

The Conquest of Space and Time

IT is a truism that the advances of physical science in the last few decades far exceed in volume and importance those in the whole of previous history: and yet these advances have reacted on our everyday lives in a curiously arbitrary way. Our houses are very much as they were fifty years ago, we still have the open coal fire, we wear very similar clothes, and our food is little altered. But once outside our homes we find ourselves in a world very different from that into which we were born

† *Geomorphology—An Introduction to the Study of Landscapes*, by A. K. Lobeck. McGraw-Hill, 25*s*.

and yet one which we have already come to take very much for granted. It is scarcely an exaggeration to say that no single factor has contributed more to this change, and to the revolution in social habits to which it has given rise, than the development of means of cheap and rapid transport.

The story of the growth of our modern forms of communication on land, at sea and in the air has been told many times, but these two books,* the first of a series of four, tell the story in a quite new and very refreshing way. There is nothing here of the sensational or sentimental which usually colours such a theme, but rather a clear and concise account of the way in which the modern train and motor car have evolved scientifically as the logical solution to practical demands. The motorist, in particular, will welcome the account of some of the engineering problems which face the car designer, many of them, such as the exact angle of the radius rods or the effect of the inertia of the exhaust gases on valve timing, seemingly so trivial and yet actually the outcome of a vast body of experimental research. It is interesting, too, to compare and contrast the train and the motor car in their different fields. Why can a car climb without difficulty a gradient of 1 in 5 while a hill one-tenth as steep is a serious obstacle to a train? Why must a locomotive weigh 100 times as much as an aeroplane engine developing the same power? Why are the brakes of a train so inefficient compared with those of a motor car? These and many other similar questions must have suggested themselves to the thinking layman, and in these books he will find the answers presented in such a way as to make him feel not only that he has some understanding of the technical problems involved but also that he can appreciate something of the elegance and beauty of a functional solution to a physical problem.

R. C. EVANS.

British Corixids

THIS pamphlet† is the first of a series to be published by the Freshwater Biological Association of the British Empire, in which it is intended to furnish illustrated keys, together with full references to the literature, dealing with those groups of freshwater organisms for which modern and easily accessible works for the identification of species are not available. Mr Macan has been engaged for some years on an ecological study of the *Corixidae*, a family of aquatic bugs which comprises the lesser water-boatmen, and his treatment of them is accurate and authoritative. Besides the key and literature list, notes are given on the distribution of the thirty-three British species. The only feature open to criticism is the somewhat confused and haphazard introduction; in spite of the numerous drawings a page devoted to a concise anatomical description of the family as a whole would have been a great help to any reader not already familiar with the group.

D. A. W.

* *The Railway* and *The Highway*, by E. B. Schieldrop. Hutchinson and Co., London, 1939, 5*s*. each.

† *A Key to the British Species of* Corixidae, by T. T. Macan. Freshwater Biological Association of the British Empire.

Great Engineers

IN reading or thinking about the history and development of engineering science it is impossible to avoid contrasting in one's mind the benefits that this development could bring to mankind with those that it actually has brought. Properly applied it could bring plenty and happiness, whereas it has in fact brought the fear of destruction to all the nations of the earth. Such thoughts do not appear to disturb at all the mind of the writer of this book,‡ who glories rather in the military applications of engineering. The following two quotations must suffice to indicate his point of view: "Guns are more important than all the chatter of philosophers", and "But these great German gunmasters to whom we owe almost the whole technical development in the first century of firearms, and who were at home in almost all countries, these great predecessors of our present-day engineers in this important and extensive field of work, are worthy of having at least some of their names and deeds put on record here. We will attempt in a few lines to do honour to German gunmasters without attempting completeness." One wonders whether every book that the young German reads, on whatever subject, contains this sort of thing as well as the irrelevant propaganda inserted at various places in this one. If it does, the effect must indeed be appalling.

The author rightly stresses the fact that great work is never done unless there is a great man behind it. To be a great engineer requires a combination of inventiveness and of dogged determination to surmount the difficulties of the early stages of the work because almost every pioneer in engineering has passed and must pass through years of neglect and disappointment. Any history of the subject shows this, and the stories of the early struggles and ultimate success of great men of the past should

‡ *Great Engineers*, by Professor C. Matschoss, translated by Dr H. Stafford Hatfield. Bell and Sons, Ltd., 12*s*. 6*d*.

be an inspiration to the young people of succeeding generations.

The book is not confined to any one branch; for example, Edison's work is discussed, but the subject most fully covered is naturally the development and application of the steam engine, including the turbine, and other forms of engine. It gives in effect a fairly complete history of this and an account of many interesting details as to the actual improvements introduced by the various successive workers in this field.

J. K. R.

An Epic of the Gobi

THERE has been a spate of news from Tartary. The journeys across Sinkiang of Peter Fleming, Ella Maillart, Sir Eric Teichmann, and Sven Hedin have all been chronicled within a year or so. Now Herr Wilhelm Filchner adds his book* on a trek from Larchow to Srinagar, by way of West China, North Tibet, and Sinkiang. His journey has an element of freshness, since he went by Cherchen, Khotan and the Karakoram, instead of by the more northerly (and more familiar) Tarim basin route.

This book is, however, in many ways a disappointment. In all its four hundred pages it never once lives up to its title; the whole text is concerned simply with the author's day-to-day struggles. It is worth reading, because of the immense difficulties with which he had to contend. Every time he signed-on camel drivers, they turned out to be rogues and thieves, perpetually on the brink of mutiny. If he bought a horse, it would certainly have vicious habits. He nearly broke his neck, crushed his foot, suffered severely from sciatica, and found that his stomach would not take *tsamba*, often the only food available. In addition, the whole of the West of China was in turmoil, and passes were liable to become invalid overnight. He suffered long imprisonment in Khotan for no good reason.

It was an epic journey, which well merited the German National Prize, which the author received. His log (for it is hardly a book) retains some of the epic character. The eighty-three plates are of good quality, but of unexciting content, and awkwardly arranged vis-a-vis the text. The translator is seldom at fault.

The author reached Srinagar in October 1937. Probably his was the last journey in the old style which will ever be taken across China. Even then lorryloads of soldiers were abroad, and minor wars were in progress in many quarters. Most of the travellers' inns were abandoned, and trade was almost at a standstill. When the present troubles have subsided, and the curious spheres of Chinese, Japanese and Russian influence have been clearly demarcated, travel may be possible again. But there will not be the long lines of graceful camels, the grave courtesy of a primitive people, or the desert splendour of rulers such as the Prince of Kurlik Gobi. There will be cars and lorries, and the brusqueness of petty military, and it is probable that Herr Filchner's book marks the end of an epoch.

R. W. KIDNER

* *A Scientist in Tartary*, by Wilhelm Filchner. Faber and Faber, 21*s*.

Select List of Books Received by *Discovery*

(*Mention in this list does not preclude review*)

Life's Beginning on the Earth. R. BEUTNER. (Chapman and Hall, 12*s*. 6*d*.)

The Quiet World of Nature. BERNARD GOOCH. (John Lane, 8*s*. 6*d*.)

Earth's Green Mantle. SIDNEY MANGHAM. (English Universities Press, 10*s*. 6*d*.)

Botany of the Living Plant. 3rd Edition. F. O. BOWER. (Macmillan, 25*s*.)

The Littoral Fauna of Great Britain. N. B. EALES. (Cambridge University Press, 12*s*. 6*d*.)

Geomorphology. A. K. LOBECK. (McGraw Hill and Co. 25*s*.)

A Systematic Regional Geography. Vol. II. Europe. J. F. UNSTEAD. (University of London Press, 7*s*. 6*d*.)

General Sciences for Schools, Vol. III. F. SHERWOOD TAYLOR. (Heinemann, 3*s*.)

The Evolution of Physics. ALBERT EINSTEIN and LEOPOLD INFELD. (Scientific Book Club, 2*s*. 6*d*.)

A Text Book of Heat, Part I. H. S. ALLEN and R. S. MAXWELL. (Macmillan, 10*s*.)

Mathematical Biology. V. A. KOSTITZIN. Translated by THEODORE H. SAVORY. Harrap, 7*s*. 6*d*.)

The Minor Planets of the Hecuba Group. The Halley Lecture. A. O. LEUSCHNER. (Oxford University Press, 3*s*. 6*d*.)

The Polar Record, No. 18. (Cambridge University Press, 2*s*.)

Arctic and Antarctic. COLIN BERTRAM. (Heffer, 7*s*. 6*d*.)

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